Human Computer Interaction

DawaTime

Project Phase 1.2

Figure 1. Digital Healthcare & Telemedicine Illustration.
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1.0 Scientific Paper: Exploring The Reasons For Self-Administration Medication Errors Among Illiterate And Low-Literate Community-Dwelling Older Adults With Polypharmacy: A Qualitative Study

Introduction

Older adults experience numerous age-related changes that increase their susceptibility to chronic illnesses such as diabetes, heart disease, hypertension, arthritis, pulmonary disease, and dyslipidemia. Studies estimate that between 55% and 98% of the elderly population suffer from multimorbidity, often requiring multiple medications. Regular use of five or more drugs, known as polypharmacy, raises the risk of drug interactions, falls, adverse reactions, and hospitalization due to reduced hepatic and renal function and other physiological declines. Medication self-administration errors (MSEs), such as incorrect dosages, mixing medications, or improper storage, further compromise treatment effectiveness and patient safety. These errors are influenced by factors including low health literacy, complex treatment regimens, cognitive impairment, and limited cooperation with healthcare providers. However, there is a lack of research exploring the causes of MSEs, particularly in developing countries where low literacy remains a major barrier. This study aims to address this gap through a qualitative approach involving doctors, pharmacists, older adults, and family caregivers [1].

Methods

Study design:

The prevalence of MSEs and their determinants among community-dwelling older individuals with polypharmacy who are illiterate or low-literate were investigated in the first quantitative phase. The results have already been published elsewhere [2]. In the second phase (the present study), a qualitative approach using conventional content analysis was employed to explore the reasons for MSEs among older adults who committed the most medication errors. In conventional content analysis, coding categories are derived directly from the text data [3].

Participants & sampling:

The study included 15 older adults with their caregivers, 4 physicians, and 7 pharmacists, selected through purposeful sampling to ensure socio-demographic diversity. Older adults were eligible if they were aged 60 or older, illiterate or low literate, taking five or more medications, and had frequent medication safety events (MSEs). Those with cognitive impairments were excluded to focus on independent community-dwelling participants. Physicians and pharmacists require at least five years of relevant experience and regular contact with older patients.

Data collection:

Data were collected through semi-structured interviews using a pre-prepared guide. Led by the first author, interviews began with a question on the causes of medication safety events (MSEs) in older adults, with participants encouraged to elaborate. Field notes were taken, and interviews were

held in private settings such as homes, offices, or pharmacies, depending on participant convenience. All interviews were audio-recorded, lasted 30–70 minutes, and continued until data saturation was reached, when no new ideas or themes emerged.

Data analysis:

The Graneheim and Lundman approach was applied for content analysis to identify themes in the interview data [4]. Verbatim transcripts were coded inductively, with conceptual labels assigned to emerging concepts. Through iterative review and author discussions, codes were compared, categorized, and refined into themes. MAXQDA 2020 was used to facilitate data management during the coding process.

Reflexivity:

The research team employed bracketing to ensure reflexivity during data collection and analysis, helping to identify and minimize potential biases, assumptions, and preconceptions.

Results

Seven major categories were found from 22 subcategories pertaining to MSEs by the inductive content analysis; these are depicted in a fishbone diagram (Figure 2), with more information given below.

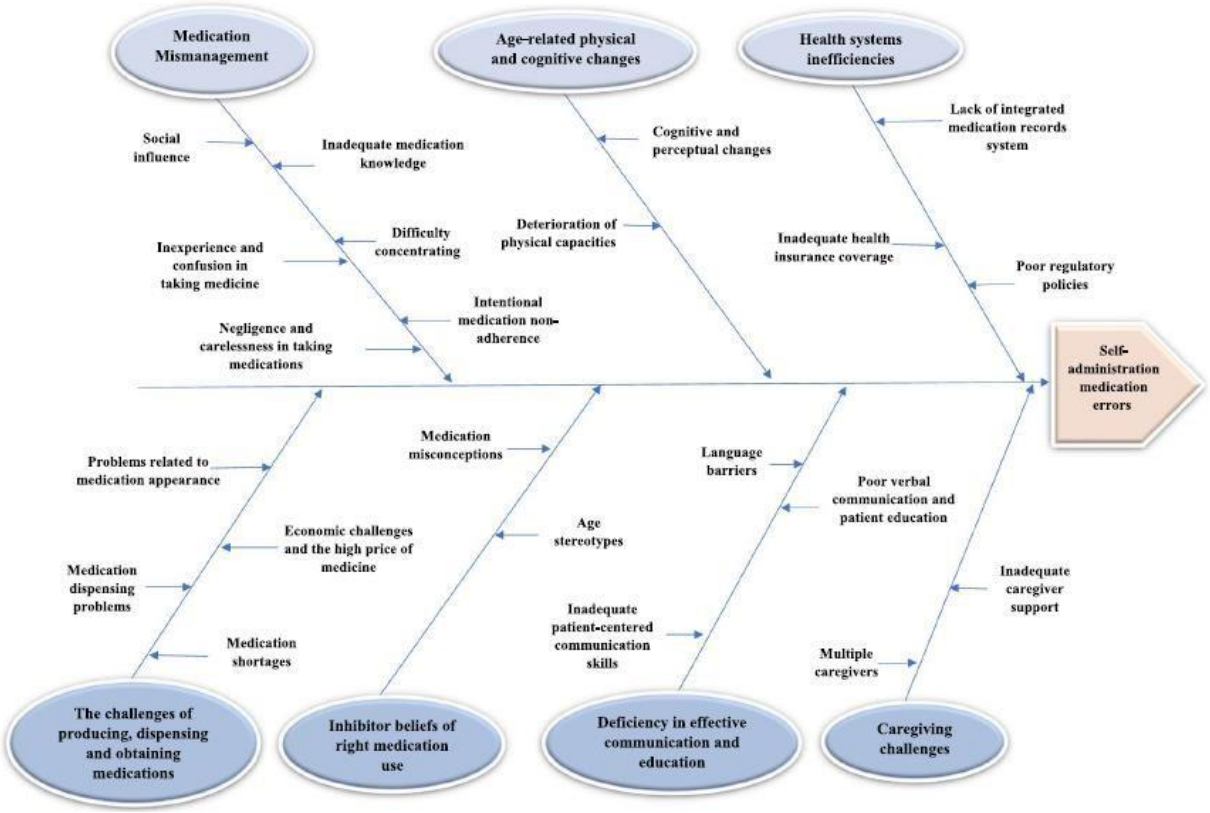

Figure 2. Fishbone diagram of main categories and sub-categories in self-administration medication errors.

Physical and cognitive changes associated with aging:

This concept relates to the cognitive and physical changes inherent in aging, which may alter functional capacities and increase the risk of medication errors. It is divided into two subcategories.

Cognitive and perceptual changes:

Age-related cognitive and perceptual deficits, such as memory loss and reduced attention, make it difficult for older adults to understand medication instructions. These impairments may lead to irregular drug use, difficulty recalling specific directions, and medication errors. Participant testimonies reflected these challenges, such as forgetting doses or misinterpreting medical advice. For example, one older woman misunderstood dosage guidelines, illustrating how misinformation can further complicate medication management.

Deterioration of physical capacities:

According to participants, particularly physicians and pharmacists, age-related sensory problems such as vision and hearing impairments significantly affect medication adherence in older adults. For those with low literacy, conditions like presbyopia make reading medication instructions especially difficult. Challenges in distinguishing pill colors and shapes can further hinder proper use. Participants also noted that reduced muscle strength complicates self-administration, as older adults may struggle with devices such as inhalers or make dosage errors due to hand tremors. In addition, multimorbidity increases the likelihood of medication errors, particularly when multiple physicians prescribe overlapping treatments without full awareness of the patient's history. Polypharmacy, in which the same drugs are prescribed by different providers, adds further complexity and risk.

Medication mismanagement:

People with low literacy levels have more difficulty managing their medications, which leads to poor self-management. This group experiences more medication adherence errors and greater disorientation, especially when polypharmacy is involved. The concept includes six subcategories.

Inadequate medication knowledge:

Patients' understanding is essential for proper drug management, especially among older adults who often do not fully grasp the significance of their prescriptions. Many people rely on the appearance of medications rather than their names to identify them, which can lead to mistakes, such as confusing sleeping pills with drugs intended for daytime use. Furthermore, a lack of awareness about important aspects of medication use such as expiration dates, side effects, and storage methods poses serious risks.

Inexperience and confusion in taking medicine:

Patients, particularly older adults, frequently make medication errors because they lack experience in managing their drugs, especially when beginning therapy. As the number of prescribed medications increases, proper management becomes more difficult, leading to confusion as well as dosage and administration errors.

Difficulty concentrating:

Daily obligations can distract people from important tasks, such as managing their medications, which may lead to mistakes like missed or delayed doses. One older participant reported that, although they sometimes took their prescription late, they occasionally forgot to take it altogether due to work and a busy schedule.

Negligence and carelessness in taking medications:

When older adults believe their prescriptions are not essential, they often neglect to take them, leading to missed doses and improper timing. For example, one person mentioned that their partner frequently forgot to take their medication, leaving it unattended on the table. Nonadherence may also be worsened by the frustration of taking multiple drugs; one patient admitted they were tired of their routine and only took their medications when prompted by a family member.

Social influence/Credulity:

Social relationships strongly influence how older adults manage their medications. Participants observed that friends and relatives can affect self-medication; for instance, one person described how her behavior changed after a neighbor suggested taking more medication. In addition, a pharmacist emphasized that, rather than seeking professional medical advice, older adults often self-medicate based on recommendations from people in their social circle.

Non-adherence to medicine on purpose:

Medication errors and non-compliance can occur when older adults alter their prescription schedules in response to symptoms. For example, if a patient cuts an enteric-coated medication in half without first consulting a doctor, the active ingredients may be destroyed by exposure to stomach acid.

Inhibitor beliefs of right medication use:

Misconceptions that affect older adults' adherence to drug regimens often stem from incorrect attitudes and beliefs about medication, which hinder proper management.

Age stereotypes:

Some older adults hold a pessimistic view of their health, believing that aging inevitably leads to death. Viewing treatment as pointless, this mentality reinforced by age-related stereotypes contributes to neglect of medication adherence. One participant expressed this perspective, stating that at the age of fifty they felt they were "just waiting for death" and saw no reason to continue taking medication. Such attitudes increase the risk of medication errors.

Medication misconceptions:

Misconceptions about medications are common among older adults and can lead to errors. Many disregards potential interactions, believing that natural products are inherently safe and that herbal remedies are superior to prescription drugs. Some also assume that taking medications at longer intervals prevents habituation, without realizing that this practice can reduce effectiveness. In

addition, certain individuals question the efficacy of smaller pills, unaware that they contain active ingredients essential for treatment.

Caregiving challenges:

For illiterate older adults, informal caregivers play a crucial role in ensuring proper medication use. The safe use of drugs in this population can be significantly influenced by factors that affect caregivers' ability to manage medications effectively.

Inadequate caregiver support:

For older adults, inadequate medication management by caregivers can have serious consequences. Errors often arise from caregivers' lack of education or limited literacy. For example, one case involved a daughter who administered medication at the wrong time and dosage, resulting in inadequate treatment of a wound infection. In addition, because informal caregivers often have busy schedules, older adults may be left to manage their medications on their own, limiting support for adherence and assistance with medical appointments.

Multiple caregivers:

When multiple caregivers are involved in medication management, inaccurate information about an older adult's prescription schedule may be communicated. One participant noted that because the likelihood of errors increases when several people handle prescriptions, designating a single caregiver to oversee medication procurement is essential to minimizing mistakes.

Deficiency in effective communication and education:

Effective patient education requires clear communication between healthcare providers and older adults. Three subcategories illustrate how poor communication can negatively affect educational outcomes.

Poor verbal communication and patient education:

Participants highlighted a serious gap in patient education, particularly for older adults, due to poor communication between physicians and pharmacists. Several factors contribute to insufficient patient questioning about medication history, including physicians' time constraints, busy clinical settings, and patient embarrassment. For instance, one illiterate patient with asthma reported taking medication incorrectly for two years without correction. Misunderstandings about prescription instructions are further reinforced by healthcare professionals' oversimplified assumptions about patients' comprehension. Altogether, these issues undermine effective patient education and medication adherence.

Inadequate patient-centered communication skills:

This study highlights the challenges in communication between older adults and healthcare providers. It emphasizes that physicians and pharmacists often lack communication skills tailored to the specific needs of older patients, which can hinder the development of an effective patient–provider relationship. Inadequate patient education also results from a failure to consider age-

related changes, such as cognitive decline. For example, older patients' understanding of medical instructions may be negatively affected by rushed communication and by healthcare professionals' refusal to accommodate requests for visual aid.

Language barriers:

In bilingual communities, language barriers make effective communication between patients and physicians difficult, leading to miscommunication about health information. Differences in word meanings across cultures and regions—for example, terms such as "Akhsham"—can cause misunderstandings. In addition, older patients, who are often illiterate, face greater challenges in understanding medical advice when healthcare providers use medical jargon, increasing the risk of misinterpretation.

Health systems inefficiencies:

Weaknesses in specific health infrastructures contribute to poorer patient outcomes, which can be further divided into three subcategories.

Lack of integrated medication records system:

In the absence of an integrated medication record system, physicians and pharmacists are often unaware of prescriptions issued by other doctors. Because essential information about a patient's previous medications—including over-the-counter drugs—is not documented, and patients may fail to disclose their current use, this can result in duplicate prescriptions or the re-prescription of similar drugs.

Poor regulatory policies:

The inadequate enforcement of regulations on non-prescription medications by the Ministry of Health is attributed to weak pharmacy oversight. Although laws exist to govern the dispensing of such drugs, one participant noted that effective control is hindered by the large number of pharmacies, ineffective regulations, and a shortage of deputy inspectors.

Inadequate health insurance coverage:

Some participants noted that certain insurance policies can affect older adults' use of medications. Inadequate coverage for specific drugs may lead individuals to skip prescriptions or medical appointments, increasing the likelihood of self-medication. For example, one participant reported preferring to purchase medications without a prescription to save money on doctor visits.

The challenges of producing, dispensing, and obtaining medications:

Four subcategories are used to further explain the causes of drug production, dispensing, and procurement problems that negatively affect medication use.

Problems related to medication appearance:

For illiterate older adults, the primary method of identifying medications is through visual appearance, which increases the risk of confusion between similar prescriptions and may lead to

dosage-related problems such as duplication. Packaging changes can also cause mistakes, as individuals may unknowingly take identical prescriptions with different labels. In addition, pharmaceutical pamphlets often lack essential visuals and are printed in small, difficult-to-read text, making it harder for this population to access necessary information. Challenges are further compounded by unclear expiration dates, which become especially problematic when combined with low vision. The situation is worsened by educational resources that fail to adequately address the needs of older adults with limited literacy.

Medication dispensing problems:

Patients are more likely to use expired medications when pharmacies dispense drugs close to their expiration date without clearly labeling them. This problem is compounded by older adults who take medications irregularly and often fail to check expiration dates. Changes in the color or shape of prescriptions may also cause confusion, leading long-term users to mistake them for new drugs, which can result in overdosing. Pharmacists acknowledged these issues, emphasizing the risk of errors when patients do not take medications on time and become confused by packaging variations.

Medication shortages:

Due to shortages of certain medication brands, pharmacists sometimes dispense two different brands of the same drug within a single prescription for older patients with limited literacy, making it difficult for them to recognize their medications. As a result, some patients may take both brands simultaneously, unaware that they are interchangeable. In addition, medication shortages can force patients to split pills that should not be altered, further increasing the risk of medication errors.

Economic challenges and the high price of medicine:

Older adults who face financial difficulties due to reduced income after retirement are more likely to self-medicate and make medication errors. Rising drug costs also encourage some to stockpile more medications than they need, increasing the risk of using expired drugs. Financial pressures on pharmacies further exacerbate the problem, sometimes leading to unethical practices such as selling prescription drugs without a prescription to boost profits.

Discussion

This study examined medication safety events (MSEs) among community-dwelling older adults with polypharmacy, focusing on illiterate and low-educated individuals—a group rarely studied. While prior work has mostly been investigated hospital settings, evidence shows that many errors in older adults occur at home during self-administration. Reviews highlight complex regimens, cognitive and physical decline, insufficient support, and low health literacy as key factors, findings echoed in this study, with illiteracy standing out as especially significant [5].

Health literacy strongly influences MSE risk. Older adults often face challenges in understanding and applying health information due to cognitive decline, physical impairments, and psychosocial barriers. Illiteracy further increases dementia risk, with illiterate adults showing weaker memory and cognitive functioning than literate peers. National assessments confirm that

most adults over 65 struggles with written information and numerical comprehension, which is linked to poor outcomes and higher medication error rates.

Additional challenges include high medication costs, limited social support, and intentional non-adherence influenced by age stereotypes. Language and communication barriers also heighten risks, especially when health providers lack time or resources to adapt education for low-literate patients.

Finally, ineffective communication during care transitions—across home, hospital, and skilled facilities—was identified as a critical factor disrupting safe medication management. Strengthening provider–patient communication tailored to older adults' literacy and cognitive limitations is essential for reducing MSEs.

Implications:

Multiple factors contribute to medication safety events (MSEs) in older, illiterate patients with polypharmacy, meaning there is no universal prevention strategy. A key approach is aligning with Healthy People 2030 goals, particularly Objective OA-02, which aims to reduce inappropriate medication use among older adults from 15.9% in 2015 to 11.2% by 2030. Unlike Healthy People 2020, which defined health literacy as an individual's ability to understand health information, the updated 2030 framework broadens the concept to include organizational health literacy, emphasizing the responsibility of health systems to make information and services accessible.

Organizational health literacy directly influences safe medication practices by empowering individuals to understand and use health information for better decision-making. Strengthening this capacity helps reduce communication-related errors that can otherwise lead to adverse outcomes. Recommended strategies for building health-literate organizations include assessing organizational literacy levels, training staff in communication, simplifying written materials, improving digital access, creating welcoming environments, ensuring easy access to services, and supporting patients in managing their health.

Conclusion

This study highlights the need for stronger organizational health literacy initiatives for older adults with limited literacy by drawing attention to participants' perceptions of the causes of medication safety incidents (MSEs). The data suggests that illiterate individuals often have inadequate health literacy and poor communication skills. Enhancing awareness of safety events linked to literacy and communication can help improve personal health literacy among older adults, particularly those who are illiterate. To effectively address MSEs, health information must be tailored to the specific needs of older patients.

1.0 Critique:

Strengths:

- Very comprehensive — you cover patient, caregiver, provider, and system-level causes of medication errors.
- Structured in IMRaD format (Introduction, Methods, Results, Discussion, Implications, Conclusion), which matches academic standards.
- Good qualitative rigor: inductive coding, use of MAXQDA, Lincoln & Guba trustworthiness criteria, reflexivity (bracketing).
- Rich results with detailed categories and subcategories supported by participant testimonies.
- Strong policy connection — linking findings to *Healthy People 2030* and the shift toward organizational health literacy.

Limitations:

- Essay is too densely long sentences, and very detailed subcategories may overwhelm readers.
- Repetition: literacy/health literacy definitions and medication packaging issues appear in multiple places.
- Balance issue: Results section is descriptive-heavy; discussion is less analytical. You mostly confirm prior studies instead of contrasting or challenging them.
- Conclusion is weak: it restates points already made but does not end with a strong call to action.

Relevance to app development:

- Highlights low literacy, communication failures, and caregiver challenges — all problems an app could address with visual aids, reminders, simplified records, or caregiver coordination features.
- Shows that packaging/appearance changes confuse older adults → an app could standardize digital medication identification.
- Identifies gaps in integrated records → an app could help reconcile prescriptions from multiple doctors.

Overall judgment:

You provided a rich, well-structured exploration of medication errors among low-literate older adults; however, the work is overly descriptive, lacks a clear discussion of limitations, and concludes without a strong actionable takeaway—highlighting the opportunity to develop an app that simplifies medication management and enhances communication between caregivers and providers.

2.0 Scientific Paper: Medication Reminder Apps To Improve Medication Adherence In Coronary Heart Disease (Medapp-CHD) Study

Study Purpose:

The study investigates the effectiveness of smartphone medication reminder apps in improving adherence to cardiovascular medications among patients with coronary heart disease (CHD).

It compares usual care with two types of apps: a simple daily medicine reminder app and a more sophisticated app with configurable and interactive features.

Study Design:

Randomized controlled trial (RCT) with 156 adult CHD patients.

Participants were randomized into three groups: routine care, rudimentary app, and sophisticated app.

Follow-up at 3 months (primary endpoint), with additional follow-ups planned at 6 and 12 months.

Primary outcome: medication adherence measured by the eight-item Morisky Medication Adherence Scale (self-reported).

Secondary outcomes: clinical measures (blood pressure, cholesterol), medication knowledge, prescription refill data, and health services utilization.

Evaluation is the process to gauge app use, acceptance, and engagement.

Intervention Details:

Basic app: provides simple, non-interactive daily reminders.

Advanced app: includes interactive features such as snooze options, tracking taken/missed doses, refill reminders, sharing adherence data with family or healthcare providers, and additional health information.

Participants received training on using the app and inputting medication information.

Key Findings (Planned/Expected):

The study aims to determine if medication reminder apps improve adherence compared to usual care.

It also seeks to evaluate whether the advanced app leads to better adherence than the basic app.

Additional goals include assessing the impact on clinical outcomes and medication knowledge.

Strengths:

Rigorous RCT design with blinding of outcome assessors.

Use of validated adherence scale and objective prescription refill data.

Inclusion of process evaluation to understand user engagement and app utility.

Systematic selection of high-quality apps for the intervention.

Addresses a significant global health issue: medication non-adherence in CHD.

Limitations:

The small sample size (n = 156 participants) limits generalizability.

A short primary follow-up period (3 months) may not capture long-term adherence or clinical outcomes.

The primary outcome relies on self-reported adherence, which may overestimate true adherence.

Potential contamination if control participants download other reminder apps.

The study is conducted in a single urban hospital, which may limit diversity.

2.0 Critique:

Strengths:

Innovative Use of Technology: The study addresses the growing use of mHealth apps, a relevant and timely intervention given widespread smartphone use.

Comprehensive Evaluation: Combining subjective (self-report) and objective (prescription refill, clinical measures) outcomes strengthens the validity of findings.

Process Evaluation: Including qualitative feedback and app usage data provides valuable insights into which app features drive engagement and adherence.

Systematic App Selection: The careful selection of apps based on quality criteria enhances the relevance and applicability of the intervention.

Weaknesses:

Short Follow-Up Duration: Three months is a relatively short period to assess sustained medication adherence and impact on clinical outcomes such as blood pressure or cholesterol.

Self-Reported Primary Outcome: Although practical, self-report measures are prone to bias and may inflate adherence rates.

Sample Size and Power: The modest sample size may limit the ability to detect smaller but clinically meaningful differences, especially between the basic and advanced app groups.

Generalizability: Conducting the study in a single hospital with English-speaking participants owning smartphones may exclude vulnerable populations less familiar with technology or those with language barriers.

Potential for Contamination: Control group participants might independently use other medication reminder apps, potentially diluting the observed effect.

Additional Considerations:

The study does not address cost-effectiveness, which is important for widespread implementation.

The intervention's impact on hard clinical endpoints (e.g., cardiovascular events) is not assessed due to short follow-up. Future research should explore long-term adherence, diverse populations, and integration with healthcare systems.

Conclusion:

This study protocol outlines a well-designed RCT to evaluate the feasibility and effectiveness of smartphone medication reminder apps in improving adherence among CHD patients. While it innovatively leverages technology and includes robust process evaluation, limitations such as short follow-up, reliance on self-reported adherence, and limited sample size should be considered when interpreting results. The findings will provide important preliminary data to guide larger, longer-term trials and inform the development of effective mHealth interventions for medication adherence.

3.0 Scientific Paper: A Mobile App For Medication Management And Symptom Tracking For Patients With Cancer: Usability Study

Introduction:

- **Pharmacological Compliance:**
  - Defined by the **World Health Organization (WHO)** as the extent to which a person's medication-taking behavior aligns with recommendations from healthcare providers.
  - Adherence is crucial for the efficacy of **antitumor drugs**. Cancer patients often have higher comorbidity burdens than non-cancer individuals, making medication management more complex.
  - Challenges include **polypharmacy**, coordination of caregivers, and managing adverse drug reactions (ADRs), which reduce adherence and can cause medical complications.
  - Several interventions exist to improve adherence and manage ADRs, but their effectiveness remains controversial.

- **WeChat and Mini Program (Applet):**
  - Over **1.1 billion monthly active users** in 2020.
  - Features include direct access without downloading, independent storage, rapid data transfer between patients and healthcare providers, and simplified follow-up management.
  - **eHealth Literacy (eHEALS)** scores can help identify patients capable of using digital health tools effectively.

- **Usability & Utility:**
  - **Usability:** The ease with which the product can achieve user goals effectively, efficiently, and satisfactorily.
  - **Utility:** The practical usefulness of the app for users.

- **Fogg Behavior Model:**
  - Three essential components for behavior adoption:
    - **Motivation**
    - **Ability**
    - **Trigger**
  - DolphinCare was designed using this model to ensure effective patient interaction.

Methods

Study Design:

- **Type:** Qualitative study to explore patient experiences regarding DolphinCare's usability and utility.
- **Ethical Approval:** Shanghai Tenth People's Hospital (SHSY-IEC-5.0/22K99/PO1); registered in Chinese Clinical Trial Registry (ChiCTR2200058189).
- **Participants:**
    - Inclusion: eHEALS ≥50%, taking ≥2 medications, ≥18 years old, no mental disabilities.
    - Purposeful sampling to include **older adults (≥65)** and **younger adults (<65)** to gather diverse perspectives.

Alpha & Beta Testing:

- **Alpha:** Design evaluation using **Fogg Behavior Model + Usability Model**.
- **Beta:** In-depth interviews from July to September 2022. Observations were noted for nonverbal cues and user difficulties.

DolphinCare Features:

Utility	Description
Individualized monitoring plan	Personalized medication monitoring with objectives, follow-up, and guidance
Small task rewards	Reward system with stars for completing small tasks
Pop-up & weekly alerts	Notifications and weekly reminders for medication
Complex medication support	Management of drug combinations and prescription changes
WeChat communication	Real-time communication with medical team for issues or emergencies
AI report recognition	Automatic recognition and conversion of medical report images into text
Adherence questionnaire	Assessment of patient medication adherence
Rehabilitation guidance	Guidance on rational medication and nutrition

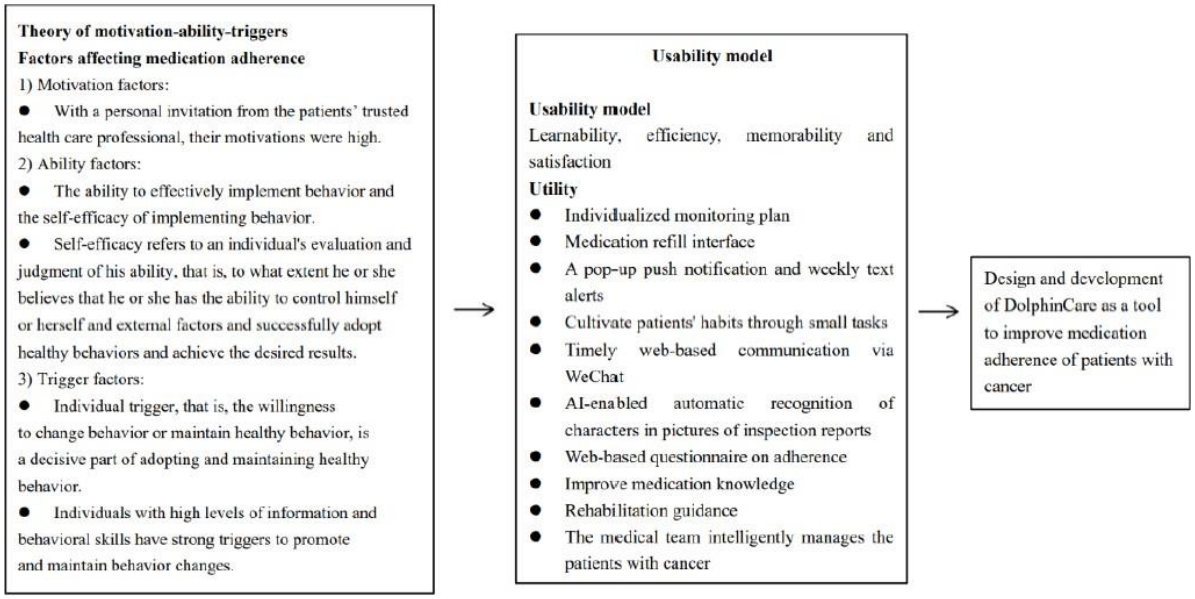

Figure 3. The conceptual framework for the design and development of DolphinCare based on the Fogg Behavior Model's theory of Motivation-Ability-Triggers and the usability model. AI: artificial intelligence.

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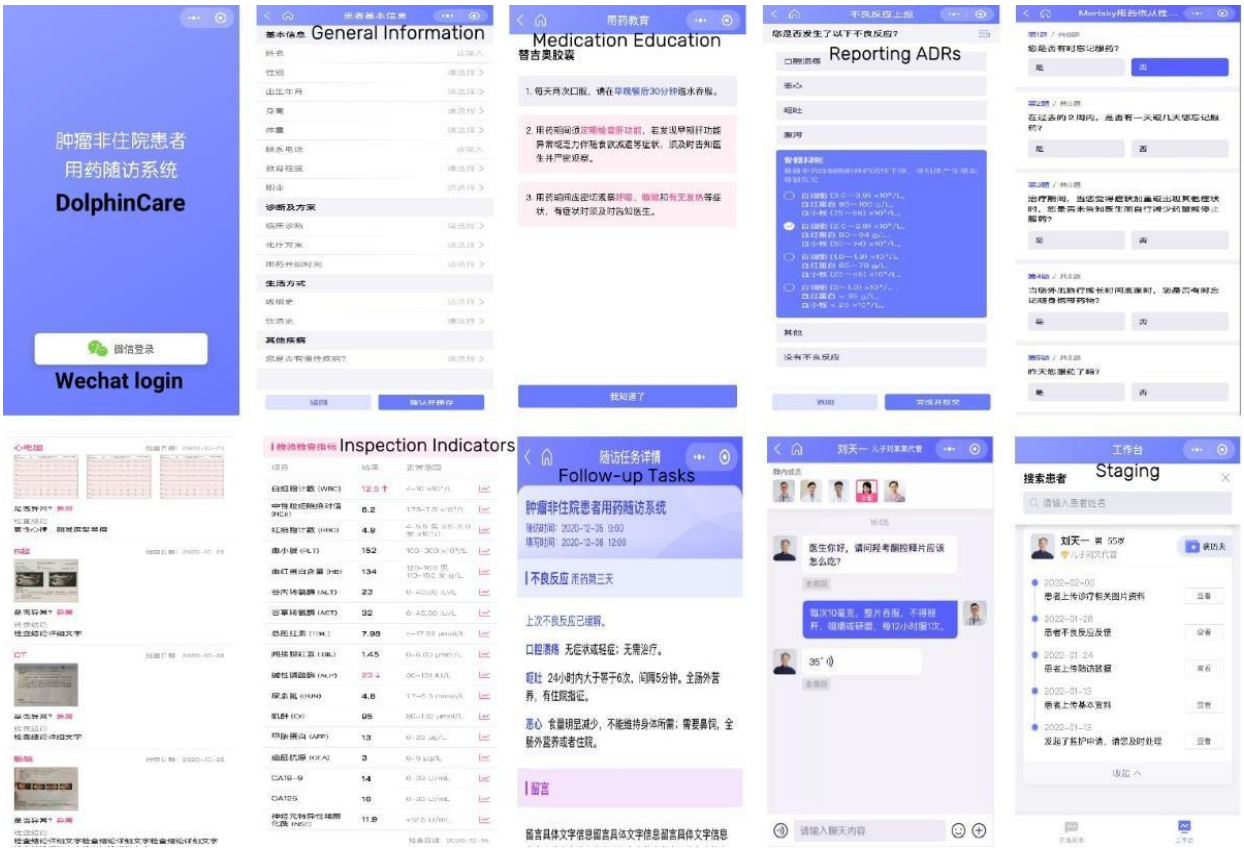

Figure 4. The landing page, registration page, home page, and pharmaceutical care page.

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Figures:

- Conceptual framework integrating Motivation, Ability, Triggers with usability model.
- App screens: Landing page, Registration, Home, Pharmaceutical Care.

Information Gathering and Evaluation:

- **Interviews:** Questions focused on initial impression, motivation, usability, challenges, and improvement suggestions.
- **Analysis:** Interpretive-descriptive approach; coding transcripts, reviewing field notes, facial expressions, and body language to identify emerging themes.

Results

Participants:

- 22 recruited; 20 interviewed (12 males, 8 females).
- Mean age: 62.4 years; average medications: 2.7
- Sample Demographics:

ID	Gender	Age	Medications	Patient/Carer	eHEALS (%)
P1	M	64	3	Carer	75
P2	F	67	1	Patient	56

Adoption Factors (Fogg Model):

- **Motivation:** Reminders to take medications, manage ADRs, contribute to medical research, reduce anxiety.
- **Ability:** Most patients could use the app independently; older adults sometimes required assistance.
- **Trigger:** Recommendations from trusted healthcare professionals and pop-up alerts.

Usability Testing:

- Challenges occurred when entering new medications due to unfamiliar generic names vs. brand names.
- Learning process increased patient knowledge about drug names, frequency, and purpose.

Utility Testing:

- **A reminder system for medications:** Pop-up and text alerts were effective.
- **Adherence Scoring:** MMAS-8 used after 1 month of app usage.
- **ADRs Management:** Automatic educational info, weekly ADR forms, online guidance from medical team.
- **Web Consultation:** Patients could consult pharmacists or physicians in real time.

Discussion:

- **Behavioral Model Application:** Fogg Model ensured adherence by combining motivation, ability, and triggers.
- **Design with the patient in mind:** Summary page for medications improved usability.
- **Learning Effect:** Manual entry improved medication knowledge.
- **Behavioral Change:** Flexible reminders improved adherence.
- **Symptom Monitoring:** Critical for cancer patients to manage side effects and maintain quality of life.
- **Demographics:** Wide age range captured perspectives from young and older users.
- DolphinCare is likely generalizable to other chronic conditions.

Conclusions:

DolphinCare demonstrated **high usability and utility** in supporting medication adherence and ADR management.

Patient-centered approach increased likelihood of adoption.

Preliminary evidence supports use of **WeChat applets** for improving cancer care and chronic disease management.

4.0 Scientific Paper: Mobile Application Development To Improve Medication Adherence In Older Adults

Introduction:

Medication adherence among older adults represents a critical challenge in healthcare. With advancing age, individuals often face multiple chronic diseases, complex medication regimens, and cognitive or physiological decline, all of which reduce their ability to take medications as prescribed. Non-adherence leads to serious clinical and financial consequences, including increased hospital visits, worsening medical conditions, and higher healthcare costs. Mobile technologies have been proposed as solutions to support patients in managing their treatment. While thousands of mobile applications exist, most lack essential functions such as reminders, clear instructions, and user-friendly designs tailored for the elderly. Given that older adults experience declines in vision, hearing, and motor skills, applications must be accessible and simple to use. However, studies have shown that many apps fail to meet these needs, highlighting the importance of developing.

Methods:

The Delphi method, an iterative consensus-building process, was applied using online surveys. Participants: Healthcare professionals (physicians, pharmacists, nurses with geriatric experience), older adults who had been using at least one medication for over a year, and caregivers with at least one year of experience. Sampling: Network sampling was used; participants were invited through email links. Process: - Phase 1: 25 questions were developed based on systematic reviews, RCTs, and observational studies. Participants rated the importance of each item (scale 1–9). - Items receiving ≥85% agreement at scores 7–9 were carried forward. - Three rounds of surveys were conducted. - Free-text responses allowed participants to propose new items. Ethical approval was obtained from the Ankara University Ethics Committee.

Results:

107 participants were invited; 56% responded in the first round. Healthcare professionals were the majority (65% pharmacists, 35% physicians). Patients and caregivers accounted for 11 participants. Survey Outcomes: - Round 1: Patients/caregivers rated more items as critical compared to healthcare professionals. - Round 2 & 3: Final consensus achieved. - Nine essential features were identified as critical for the mobile application. Key Selected Features: 1. Medication reminders (time-based alerts). 2. Confirmation after intake (patient logs medication taken). 3. Instructions for use (empty/full stomach, morning/evening, etc.). 4. Guidance on what to do if a dose is missed. 5. Visual/written instructions for special medications (e.g., insulin, inhalers). 6. Feedback on prescriptions nearing expiration. 7. Reminders for physician appointments. 8. Monitoring of vital health parameters (e.g., BP, pulse). 9. Note-taking section for patients/caregivers.

Discussion:

The study confirms that medication adherence remains a multifaceted problem among older adults. Mobile applications are promising tools to support independence, improve adherence, and reduce costs. However, to be effective, apps must be: - Evidence-based: Developed with input from

healthcare professionals. - User-friendly: Large fonts, simple layouts, and accessibility features. - Reliable and safe: Protect patient privacy and data. - Practical: Include reminders, clear instructions, and guidance for real-life medication issues. While patients and caregivers favor more comprehensive app features, healthcare professionals prefer targeted tools to avoid miscommunication. This highlights the importance of balancing usability with professional oversight. The study's limitations include: - A relatively small sample size. - Overrepresentation of pharmacists and underrepresentation of nurses. - Potential cultural and societal biases.

Conclusion:

Not all mobile applications currently include the critical features needed to support medication adherence in older adults. This Delphi study identified nine essential components that should be incorporated into all future mobile applications. By integrating reminders, confirmations, instructions, and health monitoring into a simple, accessible design, mobile applications can significantly improve adherence, reduce hospital visits, and support healthy aging. Collaboration between healthcare professionals and end-users is key to creating effective, sustainable solutions.

5.0 Scientific Paper: Do Mobile Device Apps Designed To Support Medication Adherence Demonstrate Efficacy? A Systematic Review Of Randomised Controlled Trials, With Meta-Analysis

In brief:

Armitage, Kassavou, and Sutton (2020) reviewed the impact of mobile applications on medication adherence, specifically in randomised controlled trials (RCTs) they analysed before conducting a meta-analysis with 9 RCTs, and a total of 1,159 participants in the trials, most of which had chronic conditions, and were aged over 50-years. The main outputs of the study were pooled adherence outcomes based Morisky scales, pill count, and electronic monitoring. The meta-analysis found mobile app users were significantly more likely to adhere to their medication as prescribed, and consistently found benefits in the sub-adherences that only reported using Morisky scales. Tailoring, prompts/cues, and reporting behaviour were the most prominent behaviour change techniques (BCTs); no particular BCT was significantly associated with a higher impact. Although more studies and harmonisation of measures are warranted, the authors concluded that apps could have a positive impact on adherence.

5.0 Critique:

- Strengths: PRISMA-reported, prospectively registered, and dual reviewer approaches guarantee rigour.
- Positive effects are consistent across all included studies, and validity is strengthened by low heterogeneity.
- Recall and desirability bias were introduced by the majority of trials' reliance on self-reported adherence.
- Short follow-up times (less than 16 weeks) don't show sustainability in long-term adherence.
- Generalisability to other populations was limited by the samples' age and relative small size.
- Finding effective design elements is challenging due to app variation and inadequate feature reporting.
- The inability to blind increased the possibility of performance bias.
- Because there were so few studies, it was not possible to test for publication bias.

Abstract:

In this systematic review and meta-analysis of 9 RCTs, mobile applications were found to increase medication adherence significantly more than controls. Follow-up periods tended to be relatively short (≤ 16 weeks), because six studies relied on self-reported adherence only, and there were no behavior change techniques identified in the meta-regression as effective. Mobile apps seem to help, but we still need longer-term and more reliable studies to figure out which design features truly keep people on track with their medications over time

Summary:

Older adults often stumble over medication routines hampered by shrinking memory, fading senses and limited mobility. When health literacy is thin and misunderstandings, about drug regimens run rampant the odds of self-administration errors climb sharply. Although informal caregivers are the backbone of support, they frequently find themselves under-equipped and under-supported a recipe for medication slip-ups. Adding to the mess communication breakdowns between clinicians and patients—such, as the scarcity of patient-centered conversations and half-hearted oral guidance—further entangle the issue.

Systemic challenges—such, as medication packaging, drug shortages, incomplete medication records and weak regulatory oversight—also fuel medication-safety incidents. When these factors converge, they raise the likelihood of outcomes from hospitalizations to treatment failures.

Mobile health apps are shaping up as promising levers, for lifting medication adherence. The data show that when an app incorporates nudging reminders, crystal-clear instructions, a way to log each dose taken and ongoing monitoring short-term adherence tends to climb. Building an interface that caters to the cognitive nuances of older adults is essential. Clinicians warn that piling on many features can cloud the experience so striking a balance between richness and simplicity is key to averting confusion and miscommunication.

Critiques:

The body of research examined shows a range of strengths: it digs into the root causes of medication errors applies qualitative techniques and draws on randomized controlled trials as well, as systematic reviews to gauge mobile-app effectiveness. Bringing stakeholders into the development process also helps ensure the apps address the needs.

Nonetheless notable limitations persist. Many qualitative investigations lean toward description. Lack the depth of analysis needed for conclusions. Research, on apps often features follow-up periods leans heavily on self-reported adherence—which can be biased—and tends to exclude vulnerable groups, with limited technological skills or language barriers curbing its applicability. Economic evaluations are scarce. Studies examining long-term outcomes remain largely absent. Moreover, the way digital tools are woven into healthcare networks and medication records still hasn't been tackled thoroughly. Likewise, the cultural and social forces shaping both medication adherence and technology use deserve a examination.

Final Overview and Unresolved Research Gaps:

- The scholarly record underscores the challenges of medication management for adults and flags digital interventions as a promising way to improve adherence. Nonetheless major blind spots still linger:
- Long-term Effectiveness: To see whether adherence endures and clinical benefits remain over time longitudinal studies are needed that go beyond the brief short-term improvements.

- Inclusivity: The research agenda should prioritize designing interventions that can be readily accessed by a cross-section of people—including those, with literacy varied cultural backgrounds and modest technological skills.
- System Integration: Effectively weaving medication-management tools into clinicians' workflows and electronic health records helps curb errors and sharpen coordination.
- Economic and Implementation Research: cost-effectiveness analyses and deep dives, into the obstacles of real-world implementation are crucial, for informing both policy and practice.
- Tailored Communication: Putting the effort into crafting messages and teaching aids that respect contexts and fit the audience's reading level is a priority.
- Plugging these gaps will take collaboration among disciplines and a user-centered design focus producing effective solutions that boost medication safety and adherence, for older adults.

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Armitage, Kassavou and Sutton investigated applications, for boosting medication adherence, among adults using systematic reviews and randomized controlled trials.

Santana S, Brach C, Harris L, Ochiai E, Blakey C, Bevington F, et al. Studied what healthcare professionals and older adults want in apps designed to aid medication self-management using a Delphi approach.