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Impact of Telepharmacy on Patients' Medication Adherence and Drug-Related Problem Incidents: A Systematic Review

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ABSTRACT:

Telepharmacy has evolved as a vital part of telehealth, significantly enhanced by the Coronavirus Disease 2019 (COVID-19) pandemic, which enables pharmacists to provide remote pharmaceutical care. However, despite the growing interest in and use of telepharmacy's benefits and challenges in recent years, no research has thoroughly investigated the direct impact of telepharmacy on the general public's medication adherence and the incidence rates of drug-related problems before and after pharmacy implementation. This systematic review aims to evaluate the effectiveness of telepharmacy services across all pharmacy settings worldwide on patient medication adherence and to examine their influence on reducing drug-related problem incidents. A comprehensive systematic search was conducted using four major databases (ProQuest, EBSCOHost, PubMed, and Gale), focusing on studies published between 2019 and 2024. Studies investigating the difference in patient medication adherence and drug-related problem incident rates between pharmacies providing telepharmacy services and traditional pharmacies were included in the study. Following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines, 4,385 studies were initially identified. After screening, 56 were eligible for full-text review; only eight met all inclusion criteria and passed the Joanna Briggs Institute (JBI) Critical Appraisal quality assessment. The eight eligible studies spanned diverse designs and populations across five countries (Thailand, Ghana, the United States, the United Arab Emirates, and Saudi Arabia). Quantitative synthesis revealed that medication adherence improved by approximately 10–35% in patients receiving telepharmacy interventions compared with conventional care, while drug-related problem incidents decreased by 20–40% across most studies. Most studies have demonstrated that providing telepharmacy services has a positive impact on patient outcomes, including improved medication adherence, reduced drug-related problem incidents, lower hospitalization rates, enhanced patient education, convenient consultations, more efficient healthcare delivery, and lower healthcare costs. Overall, the direction of effect consistently favored telepharmacy across the majority of included studies. Telepharmacy significantly improves patients' medication adherence and reduces drug-related incidents across varied healthcare settings. By facilitating remote counseling, education, and monitoring, telepharmacy expands access to pharmaceutical care while enhancing clinical outcomes and patient safety. These findings underscore the potential of telepharmacy to strengthen health systems, especially in resource-constrained environments, and highlight the necessity for future research to address its cost-effectiveness, scalability, and long-term impact.

Keywords: Telepharmacy; Medication adherence; Drug-related problems; Drug therapy; Medication error.

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1. Introduction

The global transmission of Coronavirus Disease 2019 (COVID-19) has placed tremendous strain on both public health infrastructures and healthcare delivery systems [1]. During this period, telehealth emerged as a key approach to maintaining and improving communication between patients and healthcare providers; it was therefore widely advocated [2, 3]. Telehealth is the use of information and communication technologies to deliver various forms of healthcare services [4].

Telepharmacy is a practical component of telemedicine that utilizes technology-based services in pharmacy practice [5, 6]. According to the American Society of Health-System Pharmacists, telepharmacy is a pharmacy practice model in which pharmacists use telecommunication technologies to supervise pharmacy activities or deliver patient-centered care [7]. Through telepharmacy, pharmacists can review medication orders, offer patient counseling, provide drug-related information, and assist in therapeutic drug monitoring [8].

During the challenging circumstances of the COVID-19 pandemic, telepharmacy transformed patient care practices by leveraging digital health technologies to safeguard the health of patients and healthcare professionals [9, 10]. Telepharmacy has been implemented in different healthcare settings, including inpatient, outpatient, ICU, hospital, and community pharmacies [9-19]. Although several developed and developing nations have adopted telepharmacy initiatives, their implementation and use remain limited in resource-limited regions due to economic and administrative challenges [9].

Following the COVID-19 pandemic, telepharmacy has become an increasingly common tool for remote pharmacists as an alternative means of delivering pharmaceutical care [20]. It is a potential solution to expand medication access and help improve pharmacy service coverage [18]. However, awareness of this technology still needs improvement [16]. Limited knowledge and understanding of the availability of telepharmacy and its impact on improving patients' medication adherence and reducing drug-related incidents can lead to missed opportunities for healthcare improvement and compromised patient outcomes.

Since telepharmacy is only partially implemented in most parts of the world, only a limited number of studies have examined its impact. Previous studies have examined the overall effect of telepharmacy models, assessed pharmacists' perceptions and preparedness, and evaluated the general public's perceptions of telepharmacy implementation [6, 9, 12, 15, 17, 21]. Some studies identified the benefits and limitations of telepharmacy in community and hospital settings in countries including Australia, the United States, the United Arab Emirates, Saudi Arabia, Portugal, Germany, Thailand, Qatar, Pakistan, Iran, and Spain.

The researcher identifies research opportunities where gaps exist in peer-reviewed literature. Since no studies have reviewed the direct impact of telepharmacy on patients' medication adherence and drug-related problem incident rates, this study sought to aggregate knowledge on the relationship between telepharmacy and these outcomes. The findings from this review will address this gap by comparing patient medication adherence and drug-related problem incidents before and after the implementation of telepharmacy in all pharmacy settings. Additionally, this study will summarize the benefits of telepharmacy across all pharmacy settings and countries, along with the roles of pharmacists in providing telepharmacy services, using peer-reviewed telepharmacy studies.

Given the research gaps, the study primarily aims to describe the impact of telepharmacy services of pharmacies on patient medication adherence and reducing drug-related problems by answering the following research questions: (1) How does telepharmacy affect medication adherence and patient health outcomes? (2) Are there significant differences between the number of drug-related problem incidents before and during the implementation of telepharmacy? Moreover, (3) What is the relationship between a patient's medication adherence, drug-related problem incident rate, and the availability of telepharmacy access?

2. Materials & Methods

This research adhered to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines as the methodological framework for conducting the review. PRISMA is an evidence-based minimum set of items and is the recognized standard for reporting in systematic reviews and meta-analyses. Organizations and journals in the health sciences endorse the standards [22]. No formal protocol registration was completed in PROSPERO or other registries before the review was conducted.

A comprehensive, systematic literature search was conducted across four major databases: ProQuest, EBSCOhost, PubMed, and Gale. The researcher conducted citation tracking and manual searches of eligible articles employing relevant keywords, including "telepharmacy," "medication adherence," "drug-related problem incidents," and their possible combinations. Furthermore, reference lists of all qualified studies were manually examined to ensure that all pertinent publications were identified and included for comprehensive coverage.

The author initially screened all articles and included only peer-reviewed studies written in English, with full text, published from 2019 to 2024. Although telepharmacy research is expanding globally, this review included only English-language publications to ensure methodological consistency and data quality. This restriction was also applied to minimize potential translation and interpretation errors that could affect the accuracy of data extraction and synthesis. Furthermore, most indexed and peer-reviewed telepharmacy studies published between 2019 and 2024 are available in English, allowing comprehensive coverage of the relevant literature while maintaining analytic rigor.

The author independently reviewed the titles and abstracts of all retrieved articles. Publications were included only if they met the inclusion criteria: using telepharmacy services in community, hospital, or outpatient pharmacy settings, and comparing results between pharmacies providing telepharmacy services and traditional pharmacies. Studies were excluded if they focused solely on assessing the perceptions or readiness of pharmacists and the public toward telepharmacy implementation, or if they failed to address the designated research questions.

After screening, the author examined all identified articles for inclusion and evaluated whether each could address the stated objectives. The eligibility criteria were established based on the Population, Intervention, Comparison, Outcome, and Study Design (PICOS) framework. Studies were deemed eligible if they investigated the effects of telepharmacy on medication adherence and the incidence of drug-related problems (DRPs). To promote transparency and facilitate reproducibility, a structured overview of the inclusion and exclusion parameters is displayed in Table 1. This table provides a detailed overview of the eligibility parameters used to identify and select studies for the systematic review.

Table 1: Inclusion and exclusion criteria.

Criteria	Inclusion	Exclusion
Population	Patients of any age group receiving pharmaceutical care through telepharmacy services	Studies focusing solely on healthcare professionals' perceptions or without patient-level data
Intervention	Implementation or use of telepharmacy (e.g., remote dispensing, virtual counseling, follow-up consultations)	Studies without a telepharmacy intervention or describing other forms of telehealth not involving pharmacists
Comparison	Traditional pharmacy services or pre-intervention baseline data	Studies lacking a comparator group or baseline data
Outcomes	Quantitative or qualitative measures of medication adherence and/or drug-related problems (DRPs)	Studies not reporting adherence or DRP-related outcomes.
Study design	Randomized controlled trials, quasi-experimental, cohort, cross-sectional, or mixed-methods studies	Review articles, commentaries, editorials, conference abstracts, or non-peer-reviewed publications.
Language	English	Non-English publications
Publication period	2019–2024	Studies published before 2019

The author removed duplicate articles, and the Joanna Briggs Institute (JBI) Critical Appraisal Checklist was applied to evaluate the methodological rigor and potential bias of all eligible studies, with criteria adapted to the specific study designs. The researcher searched across multiple databases and conducted hand searches to minimize potential publication bias. However, including only English-language publications may have introduced language bias into the review process. No subgroup or sensitivity analyses were performed due to the small number of qualified studies and the methodological variability among them.

The researcher created a standardized literature matrix to facilitate systematic, consistent data extraction. The extracted data elements from each included study comprised the author's name, year of publication, target population, research objectives, statistical approaches, analytical findings, and conclusions. The primary data items: (1) medication adherence outcomes as defined by each study, and (2) drug-related problems, including adverse drug reactions, drug-drug interactions, inappropriate treatments, overdosing, underdosing, and dispensing errors, were identified and included in the results and conclusion part of the literature matrix. The qualitative and quantitative findings were synthesized, and the results were narratively summarized and compared across studies.

3. Results & Discussion

An initial total of 4,385 records were retrieved from the four electronic databases searched. After screening, 698 articles were selected for inclusion. The author applied the inclusion and exclusion criteria, of which 56 potential studies were selected for full-text review. The author assessed the studies for risk of bias and removed duplicate studies. Only eight studies answered the study's questions. Thus, a total of eight studies were included in the final systematic review (Figure 1). Although the number of included studies was limited, substantial heterogeneity was observed across study design, population characteristics, intervention modalities, and outcome measures. This variation reflects the evolving, multidisciplinary nature of telepharmacy research and should be taken into account when interpreting the findings. This diversity highlights the broad applicability of telepharmacy interventions across varying healthcare contexts, yet also limits direct comparability due to differences in research design, outcome definitions, and sample characteristics. To provide a clearer overview of the included studies, their country distribution and research designs are summarized in Table 2.

The included studies (n=8) employed various study designs, including a cross-sectional study (n=2), a randomized controlled trial (n=3), a retrospective cohort study (n=2), and a prospective observational study (n=1).

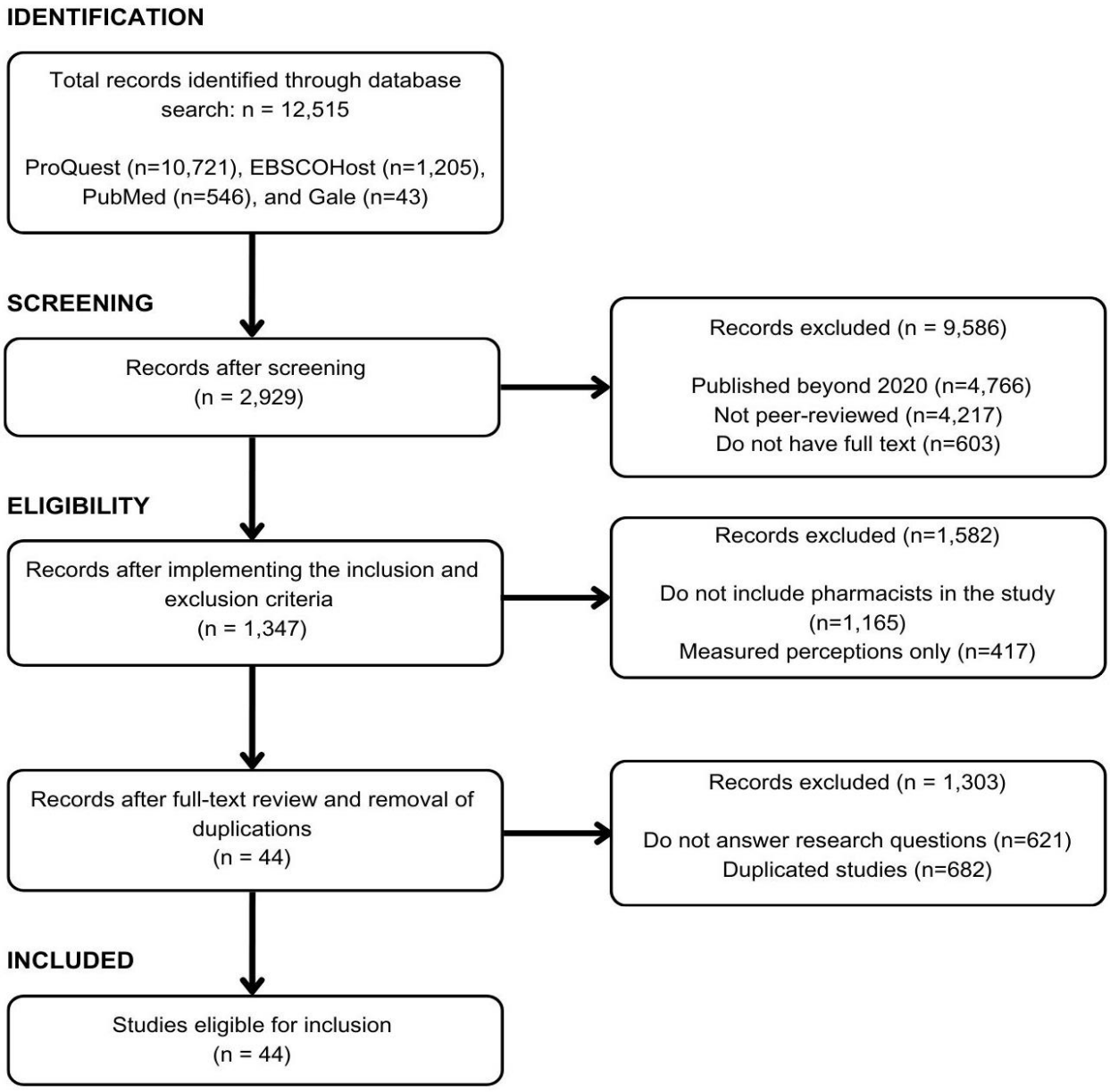

Figure 4. PRISMA flow diagram for identification of eligible studies.

Figure 1 illustrates the study selection process for this systematic review. A total of 4,385 records were identified through database searching. After removing duplicates and screening titles and abstracts, 698 studies were deemed relevant. Of these, 56 full-text articles were assessed for eligibility. Following application of inclusion and exclusion criteria and risk of bias assessment, only eight studies met all requirements and were included in the final review.

Studies originated from various countries, including Thailand (n=1), Ghana (n=1), the United States of America (n=3), the United Arab Emirates (n=2), and Saudi Arabia (n=1). Studies evaluated endpoints such as medication adherence (n=7) and drug-related problems (n=4). Table 3 presents the qualitative attributes of the studies included in the final review, while Table 4 summarizes their quantitative characteristics.

Table 2: Summary of included studies by country and study design.

Authors	Year	Country	Study design	Sample size (patients)	Primary outcomes measured
Sungsana, W. et al. 2023	2023	Thailand	Retrospective Study	197	Medication adherence and drug-related problem incidents
Mozu, I.E. et al.	2023	Ghana	Prospective Cohort	108	Medication adherence
Cigolle, C., & Phillips, K.	2023	USA	Cross-sectional	60	Medication adherence and drug-related problem incidents
Ibrahim, O.M. et al.	2022	UAE	Longitudinal	432	Medication adherence and drug-related problem incidents
Bruns, B.E. et al.	2022	USA	Retrospective Comparative Study	78	Medication adherence
Khan, Y.H. et al.	2022	Saudi Arabia	Quasi-experimental	109	Medication adherence
Ibrahim, O. M. et al	2020	UAE	Cross-sectional	52 pharmacies with 19974	Drug-related problem incidents
Pathak, S. et al.	2020	USA	Retrospective Cohort	2832	Medication adherence

Table 3: The qualitative summary of the eight included studies.

Authors, Publication Year, Country	Target population	Research objectives	Methodology	Analysis & Results	Conclusions
Sungsana, W. et al. (2023) Thailand	"Patients above 18 years old diagnosed with COVID-19 and were able to isolate at home while receiving an antiviral agent and standard symptomatic treatment."	"This study aimed to describe the drug-related problems (DRPs) and the pharmaceutical care of home-isolating COVID-19 patients receiving antiviral therapy in Thailand."	"A cross-sectional study that was undertaken from July 1 to September 30, 2021, at the King Chulalongkorn Memorial Hospital, Thailand. Infectious disease pharmacists provided a telepharmacy service on days 1 and 3 after the COVID-19 diagnosis."	"The participants' most common underlying disease was hypertension (44.29%). All patients exhibited excellent anti-COVID-19 drug adherence. They identified 125 drug-related problems, including adverse reactions (68%) and the unnecessary use of products (62.40%). Pharmacists provided 36 recommendations and received 33 questions from COVID-19 patients."	"This study showed that telepharmacy with pharmaceutical care can play a key role in preventing and detecting drug-related problems in home-isolating COVID-19 patients. As part of such an approach, multi-disciplinary collaboration is crucial and can ensure a successful outcome."

Authors, Publication Year, Country	Target population	Research objectives	Methodology	Analysis & Results	Conclusions
Mozu, I.E. et al. (2023) Ghana	Patients with hypertension	"This study sought to determine the effectiveness of pharmaceutical care interventions implemented through telepharmacy on medication adherence, practice of therapeutic lifestyles, and overall blood pressure control among patients with hypertension."	"This was a randomized controlled trial conducted in two Ghanaian hospitals from May 2022 to December 2022. Patients were assigned to a control or intervention group. Both groups were followed for six months, with the intervention group receiving telepharmacy services in addition to standard clinical care. Outcome measures included changes in blood pressure, medication adherence, lifestyle modifications, identification and resolution of pharmaceutical care issues."	"There was a statistically significant reduction in mean blood pressure for the intervention group after six months. The proportion of patients with adequately controlled blood pressure increased from 39.0% to 66.1%. There was also an increase in the mean adherence score ($p < 0.05$). The number of participants who adopted lifestyle modifications such as reducing salt consumption (89.5%) and exercising (77.2%) increased. The majority (87%) of all pharmaceutical care issues were identified and resolved over the six months. "	"Telepharmacy service provided via phone calls was effective in improving the control of blood pressure. It also promoted the practice of therapeutic lifestyle modifications, medication adherence, and identification of pharmaceutical care issues among patients with hypertension."
Cigolle, C., & Phillips, K. (2023) United States of America	US veterans	"It assessed the feasibility of the Tele-pharmacy Model of Care, its implementation by pharmacists, and its adaptability to the VA telemedicine platform. It also measured the prevalence of medication-safety issues in a group of US Veterans."	"This retrospective medical record review/abstraction analyzed data in a pilot implementation of the Telepharmacy Model of Care at the Veterans Affairs Ann Arbor Healthcare System. It assessed multiple factors in medication management (medication list accuracy, safety of medications and their combinations, older adults' cognition, impairments in self-managing medications, and caregivers' ability to compensate for those impairments)."	Participants were successful in using telemedicine. 57% of patients had four or more medication-related discrepancies; fewer patients experienced medication-adherence problems, drug–drug interactions, problematic medication combinations, and untreated/ undertreated conditions. 35% were taking contraindicated medications, and 74% were High-Risk medications. Recommendations on deprescribing were made in 98% of patients."	"Telepharmacy might be a feasible method for providing comprehensive medication review and deprescribing in older, cognitively and functionally impaired patients. Decisions on medication regimens and deprescribing should include screening for these impairments and considering them."

Authors, Publication Year, Country	Target population	Research objectives	Methodology	Analysis & Results	Conclusions
Ibrahim, O.M. et al. (2022) United Arab Emirates	Patients with hypertension	"This study aimed to assess the effectiveness of telepharmacy services delivered by community pharmacies in hypertension management and examine their influence on pharmacists' ability to identify drug-related problems."	"This was a 2-arm, randomized, clinical trial. The first arm received telepharmacy services, and the second arm received traditional pharmaceutical services. Both arms were followed up for 12 months. Pharmacists self-reported The study outcomes primarily involved changes in blood pressure from baseline to the 12-month meeting. Blood pressure readings were taken at baseline, 3, 6, 9, and 12 months. Other outcomes were the mean knowledge, medication adherence, and DRP incidence and types."	"The mean blood pressure differences were statistically significant across the study groups at 3, 6, 9, and 12-month follow-up. Medication adherence and knowledge of participants in the intervention group were significantly improved. The DRP incidence and DRPs per patient identified by pharmacists in the intervention and control groups were 2.1% versus 1.0% and 0.6 versus 0.3, respectively. The total number of pharmacist interventions in the intervention group and control group was 331 and 196, respectively."	"Telepharmacy may be useful for controlling the blood pressure and improving medication adherence of patients with hypertension. Furthermore, this tool increases pharmacists' ability to identify and prevent drug-related problems in a community setting. Therefore, the findings highlighted the importance of telepharmacy as an effective tool for the enhancement of patients' clinical outcomes."
Bruns, B.E. et al. (2022) United States of America	Patients with hypertension and co-morbidities	"This study aimed to evaluate the clinical impact of controlling high blood pressure by comparing in-person pharmacist visits to telepharmacy visits in patients with hypertension."	"A retrospective single-center cohort study that compared in-person pharmacy visits and telepharmacy visits via electronic chart review from January 2018 to July 2022. Comparator groups were patients who underwent an in-person pharmacy (pre-COVID-19) visit versus a telepharmacy visit (post-COVID-19). Medication adherence, incidence of side-effects, and blood pressure maintenance were also evaluated."	"There was no difference in the primary outcome following in-person pharmacy visits compared to telepharmacy visits. There was also no difference found for the secondary endpoints of blood pressure goal less than or equal to 140/90 mmHg, medication adherence, or antihypertensive adverse events."	"Telepharmacy visits had a nonsignificant change in blood pressure control when compared to in-person visits. Results suggest that the utilization of either in-person or telepharmacy strategies benefits the management of hypertension."
Khan, Y.H. et al. (2022) Saudi Arabia	Type-2 diabetic patients	"It aimed to evaluate the impact of Pharmacist-Based Diabetic Intervention (PDIM) for Type 2 Diabetes patients on knowledge of the disease, adherence to medications, and	"It was a multi-arm pre-post study. Patients were randomly divided into an intervention and a control group. The intervention group received the PDIM and specific telepharmacy services, whereas the	"A significant difference was observed in the knowledge score between the intervention and control group (16.89 ± 2.01 versus 15.24 ± 2.03, p-value < 0.001). Similarly, self-care practices also improved in the intervention	"PDIM (i.e., telepharmacy) is effective in improving knowledge of the disease, self-care practices, and medication adherence in the Type 2 Diabetes mellitus population, resulting in better glycemic control and fewer hypoglycemic episodes."

Authors, Publication Year, Country	Target population	Research objectives	Methodology	Analysis & Results	Conclusions
		self-care practices during the first wave of COVID-19."	control group only received the usual care. At the end of six months, disease knowledge, self-care practices, and medication adherence scores were analyzed. Furthermore, HbA1c and lipid profile were also compared."	group as compared to the control group (4.39 ± 1.10 versus 3.16 ± 0.97, p-value < 0.001). Furthermore, the medication adherence and HbA1c significantly improved during the group analysis (p < 0.05)."	
Ibrahim, O. M. et al (2020) United Arab Emirates	Community pharmacies in seven states of the UAE	"This study aimed to examine differences in rates and types of pharmacist interventions related to COVID-19 and medication dispensing errors across community pharmacies with and without telepharmacy services."	"It was a prospective, disguised, observational study conducted from March 2020 to July 2020 in 52 community pharmacies (26 with and 26 without telepharmacy) using proportionate random sampling. Researchers developed a standardized data-collection form to include information about patient status, pharmacist interventions, and medication dispensing errors."	"Rates of medication dispensing errors and their subcategories, prescription-related errors, and pharmacist counseling errors across pharmacies with telepharmacy versus those without remote services were 15.81% versus 19.43% (p<0.05), 5.38% versus 10.08% (p<0.05), and 10.42% versus 9.35% (p>0.05), respectively."	"Adopting telepharmacy service could increase patient access to pharmacy care, particularly for COVID-19 probable and confirmed cases, and reduce dispensing errors. Health authorities in the UAE were the first in the region to implement, regulate, and monitor remote pharmaceutical services."
Pathak, S. et al. (2020) United States of America	Pharmacists and customers of community pharmacies in the Midwest region of the United States	"To evaluate the relationship between telepharmacy services in rural areas and the quality of medication use"	"It was a cross-sectional study using retrospective data from the dispensing records of 3 pairs of telepharmacies and the traditional pharmacies that supported them. Researchers evaluated adherence to different medications and inappropriate use of high-risk medications."	"After covariate adjustment, researchers observed no significant differences between telepharmacies and traditional pharmacies for non-insulin diabetes medications, renin-angiotensin system antagonists, statins, and high-risk medications. However, statin use in persons with diabetes was higher in telepharmacies than in traditional pharmacies."	"The quality of medication use at telepharmacies that serve rural areas was similar to that at traditional pharmacies. Results indicate that telepharmacies provide a suitable solution for expanding medication access and that telepharmacy would not negatively affect the quality of medication use."

DRP: Drug-related problem, COVID-19: Coronavirus disease; PDIM: Pharmacist- based diabetic intervention, p: p-value, mmHg: Millimeter of mercury, HbA1c: Glycated hemoglobin.

Table 4: The quantitative summary of the eight included studies.

Authors, Publication Year, & Country	Study duration	Sample size	Mean age (years)		Gender %		Relevant Outcomes	
			IG	CG	IG	CG	Medication Adherence	Drug-Related Problem Incidents
Sungsana, W. et al. (2023) Thailand	Less than 3 months	197	45		51.26 male		"After completing the telepharmacy sessions, all patients have had good drug adherence for the COVID-19 treatment (100%)."	"125 patients (63.45%) reported drug-related problems, with adverse reactions as the most frequent, followed by unnecessary use of drugs or supplements as part of the therapy."
Mozu, I.E. et al. (2023) Ghana	7 months	108	62	62	74.6 female	84.7 female	"After 6 months, the proportion of adherent participants increased from 85.7% to 96.5% in the intervention group. There was a statistical significance between the mean adherence score at baseline and after 6 months. Additionally, there was an improvement in the adherence level of the control group, although the difference was not statistically significant. Between the control and intervention group, the level of adherence was not statistically significant (p= 0.242)."	N/A
Cigolle, C., & Phillips, K. (2023) United States of America	9 months	60	75		97 male		"There were smaller number of medication adherence problems."	"Fewer patients experienced drug–drug interactions, problematic medication combinations, and untreated/undertreated conditions."
Bruns, B.E. et al. (2022) United States of America	4 years	78	77		62.3 female		"No difference between groups was revealed for secondary outcomes of blood pressure control, medication adherence, or antihypertensive adverse events."	N/A
Ibrahim, O.M. et al. (2022) United Arab Emirates	12 months	432	61	61	54.6 male	55.8 male	"The mean score of medication adherence of the intervention group who used telepharmacy was significantly increased from 4.9 at baseline to 7.3, 7.9, 7.9, and 7.6 at 3-, 6-, 9-, and 12-month follow-up, respectively."	"The total number of drug-related problems was 113, of which 74 were reported by pharmacists in the intervention group, and 39 were reported by pharmacists in the control group."
Khan, Y.H. et al. (2022) Saudi Arabia	6 months	109	59	58	59.3 male	60 male	"The intervention group's medication adherence score was much higher in follow-up compared to the control group (p = 0.005). During the analysis between groups, a significant improvement in the intervention group was observed compared to the control group (p < 0.001)."	N/A

Authors, Publication Year, & Country	Study duration	Sample size	Mean age (years)		Gender %		Relevant Outcomes	
			IG	CG	IG	CG	Medication Adherence	Drug-Related Problem Incidents
Ibrahim, O.M. et al. (2020) United Arab Emirates	4 months	52 pharmacies with 19974 patients	N/A		N/A		N/A	"The most common types of errors detected in test group pharmacies were wrong patient (37.36%), followed by wrong drug (20.25%) and wrong quantity (16.46%) errors. However, wrong drugs (40.85%), wrong quantity (20.69%), and wrong strength (9.27%) accounted for the most frequent types of errors detected in pharmacies without remote services."
Pathak, S. et al. (2020) United States of America	18 months	2832	69	68	50.8 female	50.7 female	"After covariate adjustment, we observed no significant difference in adherence between telepharmacies and traditional pharmacies for NIDMs, RASAs, statin medications, or HRM. However, patients with diabetes who used telepharmacies had a significantly higher likelihood of statin use than those using traditional pharmacies."	N/A

Among the eight studies analyzed, seven investigated the influence of telepharmacy on medication adherence.

According to the World Health Organization, adherence refers to the degree to which an individual's actions, such as taking medications, align with the mutually agreed recommendations of a healthcare provider, encompassing treatment initiation, regimen adherence, and therapy discontinuation. [23] On the other hand, four of eight articles tackled the impact of telepharmacy on drug-related problem incidents. Drug-related problems encompass issues such as therapeutic ineffectiveness, adverse drug reactions, overdosing, underdosing, inappropriate therapy, insufficient monitoring, nonadherence, and drug-drug interactions [24]. Since studies are scarce and there is a lack of summarized evidence on differences in medication adherence and medication administration error rates before and after telepharmacy implementation, this review aimed to understand the influence of telepharmacy on patients' medication adherence and the occurrence of drug-related problems.

As shown in Table 2, this systematic review identified eight eligible studies conducted across five countries (Thailand, Ghana, the United States, the United Arab Emirates, and Saudi Arabia) and encompassing diverse populations and healthcare settings. Quantitative synthesis revealed that telepharmacy improved medication adherence by approximately 10–35% and reduced drug-related problems (DRPs) by 20–40% compared with traditional pharmacy models. However, two studies showed no statistically significant variation in adherence outcomes between telepharmacy and conventional pharmacy models, suggesting that telepharmacy's effectiveness may vary depending on contextual and implementation factors.

Six studies demonstrated a statistically significant improvement in patients' adherence to medication therapy following telepharmacy implementation. The first study observed an approximate 10–35% increase in adherence rates, with all home-isolating COVID-19 patients demonstrating full compliance and adherence with their prescribed treatment after completing telepharmacy sessions [8]. The second study reported that the proportion of adherent hypertensive patients increased from 85.7% at baseline to 96.5% after 6 months in the intervention group receiving telepharmacy services, and a statistically significant difference was observed in mean adherence scores between baseline and 6 months [25]. The third study documented a significant increase in medication adherence scores among patients with type 2 diabetes, showing a mean improvement of more than 20% compared with the control group ($p < 0.001$) [28]. The fourth study found that adherence scores among patients with hypertension improved from 4.9 at baseline to 7.6 after 12 months of telepharmacy intervention. This improvement can largely be attributed to participants' enhanced knowledge and awareness of

complications, symptoms, and risk factors, which were also significantly improved in this study [27]. Lastly, the fifth study reported 100% adherence among home-isolating COVID-19 patients after completing telepharmacy sessions.

In comparison, the sixth study reported a reduction in medication adherence problems and discrepancies of over 25% from baseline [8, 26]. These findings indicate a consistent and clinically meaningful improvement in adherence across studies implementing telepharmacy. Evidence from the reviewed studies suggests that the observed improvement in adherence may be attributed to pharmacists' active engagement and follow-up through teleconsultations, which helped resolve medication-related issues and reinforced the importance of adherence [28].

On the contrary, two studies found no notable difference in patients' medication adherence between those utilizing telepharmacy and those receiving care from traditional pharmacies. One study, after adjusting for covariates, reported no significant difference ($p>0.05$) in adherence levels between telepharmacy and traditional pharmacy users across non-insulin diabetes medications (NIDMs), renin-angiotensin system antagonists (RASAs), statins, and high-risk medications (HRMs). However, diabetic patients who accessed telepharmacy services had a significantly greater likelihood of statin use than those who used conventional pharmacy services [19]. Another study also found no statistically significant difference ($p>0.05$) in blood pressure control or medication adherence outcomes between telepharmacy consultations and face-to-face visits. However, the article emphasized that patients may have performed self-measurements inaccurately, and that telepharmacy sessions were led remotely by pharmacy students or residents. During these sessions, a licensed pharmacist provided background supervision. Such circumstances may have caused patients to withhold full medical details or to adhere less rigorously to professional recommendations than they would during in-person interactions, potentially influencing the study outcomes [29].

The generally positive trends observed in this review suggest that telepharmacy holds promise for enhancing patient adherence and medication safety; however, these improvements must be interpreted with caution. Much of the available evidence derives from observational or quasi-experimental designs, which are inherently limited by potential confounding factors, selection bias, and lack of randomization. Additionally, heterogeneity in outcome measurement, such as the use of self-reported adherence scales versus prescription refill data, makes direct comparison across studies difficult. The two studies that did not find significant improvements may reflect variations in intervention intensity, patient engagement, or follow-up duration. These inconsistencies underscore the importance of tailoring telepharmacy models to local healthcare structures, patient literacy levels, and the availability of technology infrastructure.

On the other hand, four studies examined the impact of telepharmacy on drug-related problem incidents. Findings from one study indicated that telepharmacy use was associated with a reduction in cases of drug–drug interactions, inappropriate medication combinations, and untreated or undertreated conditions among patients [26]. Another study revealed that pharmacists in the telepharmacy intervention group identified almost twice as many DRPs (2.1% vs. 1.0%), with efficacy and safety-related issues being the most common types of drug-related problems [27]. This allowed earlier intervention and resolution. In line with this, another study reported that, through telepharmacy, pharmacists identified 125 DRPs among 197 COVID-19 patients, primarily adverse reactions (68%) and unnecessary drug use (62%), demonstrating telepharmacy's ability to promptly detect and address medication-related issues [8]. Furthermore, a 2020 study reported a 15.81% error rate in telepharmacy-equipped pharmacies, compared with 19.43% in conventional settings ($p < 0.05$), indicating a relative reduction of approximately 20%. It also stated that pharmacies lacking remote telepharmacy services most frequently encountered dispensing errors involving incorrect drug selection, improper quantity, and inaccurate medication strength [1]. Collectively, these results provide quantitative support for the notion that telepharmacy interventions improve medication adherence by approximately 10–35% and reduce DRP incidence by 20–40%, confirming their overall positive impact on patient safety and therapeutic outcomes.

The findings of this review underscore the importance of telepharmacy as a vital strategy for expanding access to pharmaceutical care, particularly in resource-constrained settings. By enabling remote patient monitoring, medication review, and counseling, telepharmacy enhances continuity of care and patient safety. These outcomes align with the global trend in healthcare toward digital transformation and the integration of telehealth systems. Moreover, the consistent positive direction of effect across the included studies supports integrating telepharmacy into national health policies and routine pharmacy practice to improve adherence, reduce medication errors, and optimize clinical outcomes.

The results of this review align broadly with previous research and empirical evidence assessing the effectiveness of pharmacist-led telepharmacy interventions. However, this review provides more specific quantitative evidence on adherence and reduction of drug-related problems, emphasizing the range of improvement across diverse healthcare settings. Unlike earlier reviews that primarily discussed feasibility and acceptability, this study focused on measurable clinical outcomes, thereby contributing updated evidence

on telepharmacy's direct therapeutic impact. Moreover, the inclusion of two studies showing no significant difference underscores that telepharmacy's effectiveness is not universal and may depend on factors such as patient population, intervention duration, and level of pharmacist engagement. This nuanced finding adds depth to the existing literature, suggesting that while telepharmacy can enhance adherence and safety in most settings, its success relies on contextual adaptation and sustained implementation.

This systematic review represents the first comprehensive analysis to evaluate the direct effects of telepharmacy on patients' medication adherence and the incidence of drug-related problems before and after its implementation. This study was comprehensive, as the electronic search was conducted across four major and extensive databases. Despite the promising results, this study has several limitations. First, although this literature review compiles a comprehensive source of studies from different countries (e.g., the United States of America, Ghana, Thailand, the United Arab Emirates, and Saudi Arabia) and broad telepharmacy services delivered to various fields of pharmacy (e.g., community, hospital, or outpatient pharmacy), publication bias may have occurred since only English-language, peer-reviewed studies with full texts were included, possibly excluding relevant gray literature or unpublished data with negative or neutral results. Second, the included studies exhibited considerable heterogeneity in their designs (randomized controlled trials, cross-sectional, retrospective, and prospective studies), outcome measures, and patient populations, limiting direct comparability across studies. Third, a meta-analysis was not performed due to the small number of eligible studies and their methodological heterogeneity, which limited the feasibility of calculating pooled effect sizes or conducting subgroup analyses. Finally, as telepharmacy continues to evolve, most studies have been short-term and context-specific, underscoring the need for longitudinal, multi-center research to validate these findings.

4. Conclusion

Telepharmacy significantly improves patients' medication adherence and reduces incidents of drug-related problems. Across the eight included studies, adherence rates increased by approximately 10–35% and drug-related problems decreased by 20–40% compared with traditional pharmacy models. Medication adherence is a vital determinant of clinical outcomes, and telepharmacy serves as an effective strategy to enhance adherence among patients with diverse health conditions and comorbidities. By enabling remote counseling, follow-up, and monitoring, telepharmacy enhances patient engagement and facilitates the earlier identification and resolution of medication-related issues, compared to traditional methods. Furthermore, it enhances the quality and accessibility of pharmaceutical care while alleviating burdens on healthcare systems. In summary, through telepharmacy, pharmacists can promote medication adherence and identify and resolve drug-related problems promptly, thereby ensuring optimal clinical outcomes. Hence, telepharmacy offers a promising strategy to enhance patient safety and treatment outcomes, particularly in resource-constrained settings. Future research should aim to assess the long-term effectiveness, cost-effectiveness, and integration of telepharmacy within national healthcare systems.

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Conflict of interest

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