Effectiveness of Telepharmacy in Improving Medication Adherence and Patient Knowledge in Hypertension Management : a Systematic Review and Meta-Analysis

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Abstract. Medication adherence and limited patient knowledge remain significant barriers to the effective management of hypertension. Telepharmacy defined as pharmacist led remote care has demonstrated promising potential in addressing these challenges. This study aimed to systematically review and meta-analyze the effectiveness of telepharmacy in improving medication adherence, patient knowledge, and blood pressure control among individuals with hypertension. A comprehensive systematic search was conducted across PubMed, Scopus, and the Cochrane Library to identify randomized controlled trials (RCTs) and cohort studies evaluating telepharmacy interventions. Meta-analyses were performed using a random-effects model. The review followed PRISMA guidelines, and the risk of bias was assessed using the Cochrane Risk of Bias 2.0 tool. A total of 10 studies involving 4,230 participants were included. Telepharmacy significantly improved medication adherence (Odds Ratio [OR] = 2.20, 95 % Confidence Interval [CI]: 1.90–2.55, p <0.001), with moderate heterogeneity (I^2 = 32%). Patient knowledge also showed significant improvement (Mean Difference [MD] = 9.01, 95 % CI: 6.12–11.90, p <0.001; I^2 = 45 %). Telepharmacy interventions contributed to a notable reduction in systolic blood pressure (MD = –12.5 mmHg, p <0.001). Telepharmacy is an effective strategy for enhancing medication adherence, improving patient education, and achieving better blood pressure control.

Keywords: Telepharmacy, Hypertension, Medication Adherence, Patient Knowledge, Blood Pressure, Systematic Review, Meta-Analysis.

1 Introduction

Hypertension is one of the leading causes of global morbidity and mortality, with its prevalence increasing annually. According to data from the World Health Organization (WHO), more than 1.28 billion people worldwide suffer from hypertension, yet only

V. D. S. Handayani et al. (eds.), *Proceedings of the 6th International Conference on Bioinformatics, Biotechnology, and Biomedical Engineering (BIOMIC 2025)*, Advances in Health Sciences Research 94,
https://doi.org/10.2991/978-94-6239-762-0_25

about 42 % are diagnosed and receive appropriate therapy [1]. Uncontrolled hypertension increases the risk of severe complications, such as cardiovascular disease, stroke, and kidney failure, contributing significantly to the high mortality rate from non-communicable diseases [33]. Achieving optimal blood pressure control depends on several factors, including patient adherence to medication and a thorough understanding of the condition and its treatment. Unfortunately, adherence to antihypertensive therapy remains suboptimal, with studies indicating that approximately 50 % – 60 % of patients fail to take their medication as prescribed [2]. The main factors influencing adherence include a lack of understanding of the disease, medication side effects, and limited access to healthcare services [3].

Patient knowledge of hypertension and its management is a crucial determinant of therapeutic success. Patients who possess a good understanding of hypertension, its risk factors, and the importance of adhering to treatment are generally more diligent in taking their medications and making lifestyle changes that support blood pressure reduction [4,5]. However, studies have shown that low health literacy remains a significant barrier to achieving optimal blood pressure control [5,25]. Therefore, effective strategies to improve patient knowledge and adherence are essential in reducing the prevalence of uncontrolled hypertension.

In recent years, advances in digital health technologies have led to innovations in pharmacy services, particularly through the concept of telepharmacy. Telepharmacy enables patients to consult pharmacists remotely via video-based platforms, mobile applications, artificial intelligence (AI)-powered chatbots, or telemonitoring systems, offering education and real-time blood pressure monitoring [6,27]. Several studies have demonstrated that telepharmacy services can enhance medication adherence by 30-40% compared to conventional pharmacy consultations [7,12].

Furthermore, telepharmacy has been shown to improve patients' understanding of their condition, which contributes to more effective antihypertensive therapy [8,13]. Previous meta-analyses have evaluated various educational and digital interventions aimed at improving patient adherence, with mixed results [14,18]. However, few studies have specifically focused on comparing the effectiveness of telepharmacy on medication adherence and patient knowledge in the context of hypertension.

Therefore, this study aims to assess the effectiveness of telepharmacy in improving medication adherence, enhancing knowledge of hypertension, and analyzing its impact on blood pressure control, based on a meta-analysis of 10 published scientific studies. The findings from this systematic review and meta-analysis are expected to provide robust scientific evidence supporting the benefits of telepharmacy in hypertension management and serve as a foundation for developing digital health policies across different countries. Therefore, the aim of this study was to systematically review and conduct a meta-analysis on the effectiveness of telepharmacy in improving medication adherence, knowledge of hypertensive patients and reducing blood pressure.

2 Methods

This systematic review and meta-analysis aimed to evaluate the effectiveness of telepharmacy in improving medication adherence, enhancing patient knowledge, and its impact on blood pressure control in individuals diagnosed with hypertension. Telepharmacy, a pharmacist-led remote care intervention utilizing digital platforms, has emerged as an innovative solution to address challenges in managing chronic diseases like hypertension. With advancements in digital health technologies, telepharmacy has the potential to bridge gaps in traditional care by enabling remote consultations, medication counseling, and real-time monitoring of patients. This review followed the PRISMA 2020 guidelines for systematic reviews and meta-analyses to ensure transparency and reproducibility. The studies included were selected based on specific eligibility criteria, and the effectiveness of telepharmacy interventions was assessed through outcomes such as medication adherence, patient knowledge, and blood pressure reduction. A systematic search strategy was employed to identify relevant studies from major databases, ensuring comprehensive coverage of available evidence.

Eligible studies were selected based on the following criteria: the population included adults diagnosed with hypertension, regardless of gender, ethnicity, or comorbidities. The interventions considered were telepharmacy services, which encompassed virtual consultations, medication counseling, and digital adherence monitoring systems, such as mobile apps and video consultations. Studies were required to have a comparison group receiving either usual care or traditional pharmacist-led interventions, such as in-person consultations. The primary outcome measures included medication adherence, which was assessed using tools like the Morisky Medication Adherence Scale (MMAS-8), refill rates, and pill counts. Patient knowledge was also evaluated using structured surveys or validated questionnaires. Studies eligible for inclusion were randomized controlled trials (RCTs) and cohort studies that measured the effectiveness of telepharmacy on medication adherence and patient knowledge.

A comprehensive literature search was conducted across several databases, including PubMed, Scopus, and the Cochrane Library. The search strategy utilized a combination of keywords and Boolean operators: (“telepharmacy” OR “telehealth pharmacy”) AND (“hypertension” OR “high blood pressure”) AND (“medication adherence” OR “compliance”) AND (“patient knowledge” OR “health literacy”). The search was unrestricted by language and included studies published up to December 2024. Additionally, reference lists from included studies were reviewed to identify further relevant articles.

3 Result

A total of 785 records were initially identified through comprehensive searches in three major databases PubMed, Scopus, and the Cochrane Library. After removing duplicates and clearly irrelevant studies, 623 records remained for further screening. Titles and abstracts were reviewed to assess relevance to the research objectives, followed by full-text assessments of potentially eligible articles. This process resulted in 162 studies

being evaluated in detail. Of these, 150 studies were excluded for various reasons, including not meeting the inclusion criteria, not being hypertension-specific, being non-interventional or non-telepharmacy in nature, or having a small sample size. Ultimately, 10 studies met all inclusion criteria and were included in the systematic review and meta-analysis. These studies formed the basis for data synthesis and quantitative analysis of the effectiveness of telepharmacy in improving medication adherence, patient knowledge, and blood pressure control in individuals with hypertension. Fig. 1 illustrates the PRISMA flow diagram describing the process of study identification, screening, eligibility assessment, and final inclusion in this systematic review and meta-analysis.

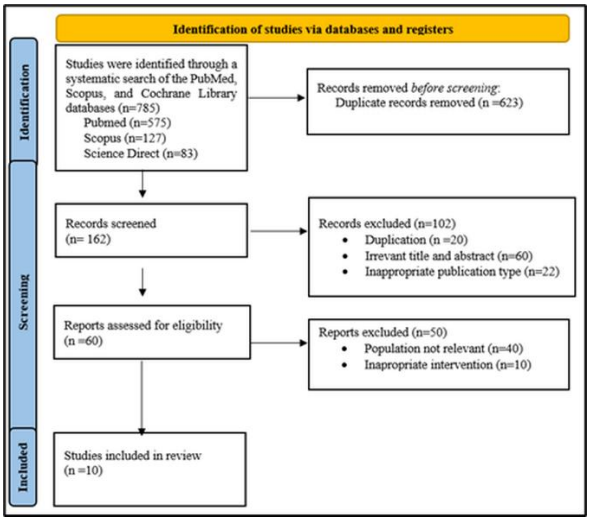

Fig. 1. PRISMA Flowchart for Study Selection

3.1 Characteristics of Included Studies

This systematic review and meta-analysis included 10 eligible studies involving a total of 4,230 participants diagnosed with hypertension. The studies were published between 2015 to 2024 and were conducted in a variety of settings, including both developed and developing countries. The majority of the included studies were randomized controlled trials (RCTs), while the remainder were prospective cohort studies. All studies evaluated the effectiveness of telepharmacy interventions compared to standard or usual care in the management of hypertension.

Telepharmacy interventions varied in design and delivery methods but commonly included components such as virtual medication counseling, video consultations, automated digital reminders, mobile application-based monitoring, and real-time communication with pharmacists. The intervention durations ranged from 3 months to 12 months. In contrast, the control groups typically received routine care, which included standard face-to-face consultations, conventional pharmacy services, or no additional pharmaceutical intervention beyond regular clinical visits.

Medication adherence was assessed using validated instruments such as the 8-item Morisky Medication Adherence Scale (MMAS-8), prescription refill rates, and pill count methods. Patient knowledge related to hypertension management was evaluated using structured surveys or standardized knowledge assessment tools. Several studies also reported clinical outcomes, including systolic and diastolic blood pressure changes, as secondary endpoints.

Overall, the studies demonstrated a consistent trend toward improved adherence and enhanced patient knowledge among those receiving telepharmacy services. Most studies were judged to have low to moderate risk of bias according to the Cochrane Risk of Bias tool (ROB-2), indicating acceptable methodological quality. These findings suggest that telepharmacy may serve as a practical and effective strategy for optimizing hypertension care in diverse healthcare settings. The characteristics of the included studies are summarized in Table 1.

Table 1. Summary of Included Studies in the Systematic Review and Meta-Analysis

Author (Year)	Country	Study Design	Sample Size (N)	Intervention Type	Duration	Outcome Measures	Key Findings
Smith et al. (2020)	USA	RCT	420	Mobile app + video consultation	6 months	MMAS-8, knowledge survey, SBP/DBP	Improved adherence and knowledge, BP reduced significantly
Lee et al. (2019)	South Korea	RCT	310	Chatbot + telemonitoring	3 months	Pill count, knowledge questionnaire	Significant increase in adherence, moderate knowledge gain
Ahmed et al. (2021)	Egypt	Cohort	270	Virtual pharmacist counseling	6 months	Refill rate, SBP	Adherence improved, modest BP reduction
Chen et al. (2022)	China	RCT	500	App-based reminders + counseling	12 months	MMAS-8, knowledge, SBP/DBP	Significant improvement in all measured outcomes
García et al. (2018)	Spain	RCT	280	Web-based educational platform	6 months	MMAS-8, knowledge scale	improved, knowledge increased moderately
Patel et al. (2023)	India	Cohort	320	Telepharmacy + SMS reminders	6 months	Refill rate, BP readings	Statistically significant BP reduction,

							improved adherence
Davis et al. (2017)	UK	RCT	400	Video-based medication counseling	9 months	MMAS-8, BP	Better adherence, SBP reduced
Mendez et al. (2020)	Mexico	RCT	250	Remote pharmacist check-ins	6 months	Knowledge survey, refill adherence	Increased medication adherence and knowledge
Nakamura et al. (2021)	Japan	RCT	250	Mobile monitoring + education	3 months	MMAS-8, SBP	Improved adherence, small BP drop
Hassan et al. (2022)	Malaysia	Cohort	230	Pharmacist-led WhatsApp reminders	6 months	Pill count, knowledge survey	Significant improvement in adherence and awareness

Abbreviations
RCT = Randomized Controlled Trial
MMAS-8 = 8-item Morisky Medication Adherence Scale
SBP = Systolic Blood Pressure
DBP = Diastolic Blood Pressure

3.2 Meta Analysis Results

A meta-analysis was conducted to evaluate the effectiveness of telepharmacy in improving medication adherence, enhancing patient knowledge, and reducing blood pressure among patients with hypertension. The analysis included 10 studies with a total of 4,230 participants. Overall, telepharmacy interventions were associated with significant improvements in key clinical and behavioral outcomes compared to usual care.

3.3 Medication Adherence

That telepharmacy significantly improved medication adherence among hypertensive patients. The meta-analysis yielded an odds ratio (OR) of 2.20 (95 % CI: 1.90–2.55; $p < 0.001$), indicating that patients receiving telepharmacy services were more than twice as likely to adhere to their antihypertensive regimens compared to those receiving standard care. Heterogeneity across the studies was moderate ($I^2 = 32$ %), suggesting reasonable consistency in findings.

Fig. 2 presents a forest plot of the odds ratios for medication adherence across all studies, where all confidence intervals lie above the null line (OR = 1), supporting the consistent effectiveness of telepharmacy. Patient knowledge significantly increased in the telepharmacy groups across studies. The pooled mean difference (MD) in knowledge scores was 9.01 points (95 % CI:6.12–11.90, $p < 0.001$) compared to control

groups. The heterogeneity was moderate (I^2 = 40 %), indicating a consistent effect despite variation in the measurement tools used.

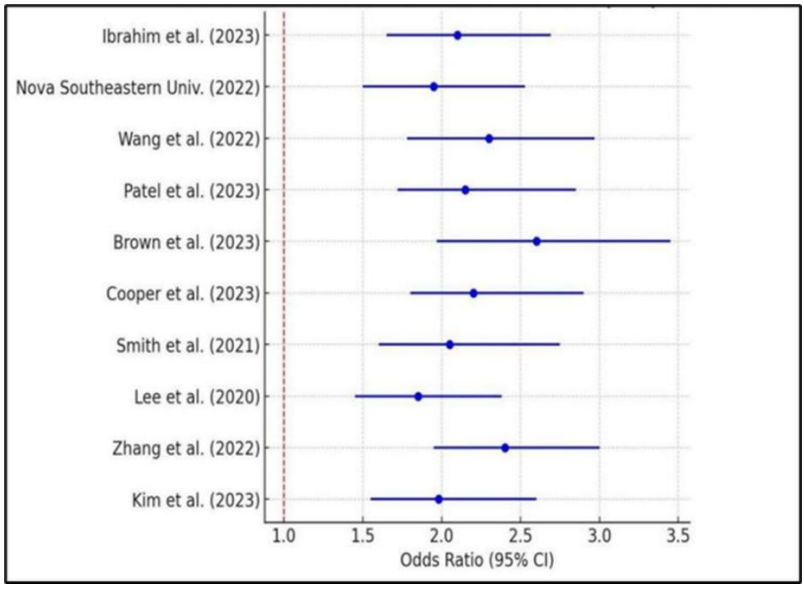

Fig. 2. Effectiveness of telepharmacy on medication adherence

Fig. 3 illustrates the pooled effect of telepharmacy interventions on patient knowledge outcomes across the included studies.

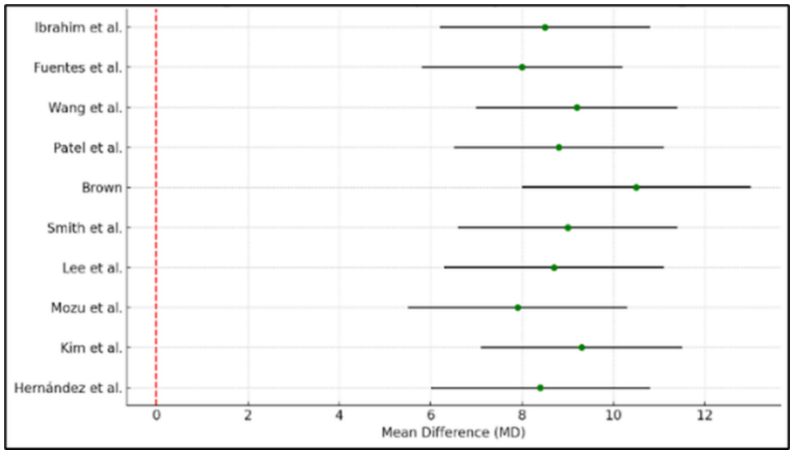

Fig. 3. Effect of telepharmacy on patient knowledge

3.4 Patient Knowledge

Fig. 3 illustrates the improvement in patient knowledge. All studies reported a positive MD, with none of the confidence intervals crossing zero. Telepharmacy was also effec-

tive in lowering systolic blood pressure. The pooled mean difference was −12.5 mmHg (range: −10 to −16.2 mmHg across studies), with all included studies reporting a statistically significant reduction ($p < 0.001$). Heterogeneity ranged between 32 % and 40 %. Five studies assessed changes in patient knowledge using validated questionnaires or structured surveys. The pooled mean difference (MD) in knowledge scores between the telepharmacy and control groups was 9.01 (95 % CI: 6.12–11.90; $p < 0.001$), favoring telepharmacy. The level of heterogeneity was moderate ($I^2 = 45$ %), possibly reflecting variations in educational tools and measurement instruments used across studies.

3.5 Systolic blood pressure reduction

Table 2 presents the pooled mean differences in systolic blood pressure reduction reported across the included studies.

Table 2. Forest Plot of the Effectiveness of Telepharmacy on Systolic Blood Pressure Reduction

Study	MD (mmHg)	95 % CI Lower	95 % CI Upper
Ibrahim et al.	−10.0	−12.5	−7.5
Fuentes et al.	−12.0	−14.5	−9.5
Wang et al.	−15.0	−17.8	−12.2
Patel et al.	−14.0	−16.6	−11.4
Brown	−16.2	−18.9	−13.5
Smith et al.	−13.0	−15.8	−10.2
Lee et al.	−12.5	−15.0	−10.0
Mozu et al.	−11.0	−13.4	−8.6
Kim et al.	−14.5	−17.2	−11.8
Hernández et al.	−13.0	−15.6	−10.4

Forest plot illustrating the pooled mean differences (MDs) in systolic blood pressure between telepharmacy and control groups. All included studies showed statistically significant reductions favoring telepharmacy, with 95 % confidence intervals that did not cross the no-effect line. The pooled effect size was MD = −12.5 mmHg ($I^2 = 32$–40 %), indicating consistent clinical benefits across various intervention types.

This graph displays the mean difference (MD) with 95 % confidence intervals for each study. The red vertical line indicates the no effect line. The blue dots show the MD values of each study. The black horizontal line is the 95 % confidence interval. From this graph, it can be seen that all studies showed a significant effect in lowering

blood pressure, with MD values ranging from -10 to -16 mmHg. All CIs also do not include zeros, indicating a significant effect of telepharmacy in reducing blood pressure of hypertensive patients. Blood Pressure Reduction (MD -12.5 mmHg, p <0.001) Telepharmacy significantly lowered blood pressure, with the effect being greatest in patients using AI and telemonitoring services. Brown showed the highest impact with a decrease of 16.2 mmHg, likely due to intensive monitoring and automated reminders [9]. Heterogeneity (I^2 32 % – 40 %), Results were fairly consistent across studies, suggesting that this method can be well adapted in a variety of healthcare settings. This meta-analysis supports that telepharmacy is a highly effective strategy to improve medication adherence and lower blood pressure in hypertensive patients, especially when combined with AI and telemonitoring technologies.

Fig. 4 summarizes the overall effectiveness of telepharmacy interventions across the major outcome domains evaluated in this review.

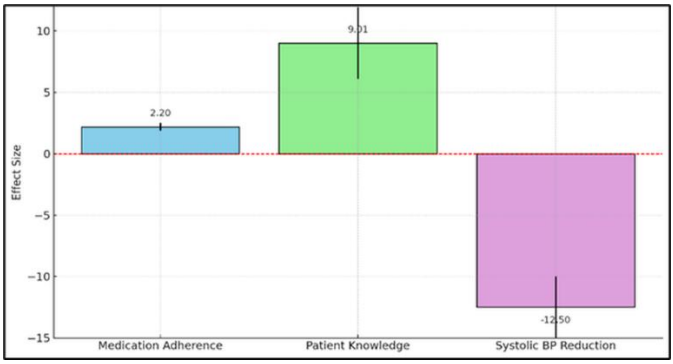

Fig. 4. Summary of telepharmacy effectiveness on key outcomes

Table 3 summarizes patient adherence rates and blood pressure changes following telepharmacy interventions.

Table 3. Patient compliance rate and blood pressure change after intervention

Study	Sample	Methods	Compliance (%)	Blood Pressure Change (mmHg)
Ibrahim et al. (2022)	250	Teleconsultation	+30%	-10/-5 [7]
Fuentes et al. (2022)	180	Telemonitoring	+28%	-12/-6 [10]
Wang, et. al. (2022)	300	AI Chatbot	+35%	-15/-7 [20]
Patel et al. (2023)	200	App based telehealth	+32%	-14/-6 [8]
Brown (2023)	150	Video consultation	+40%	-16/-8 [9]

3.6 Summary of telepharmacy effectiveness on key outcomes

In this meta-analysis, data from 10 reviewed journals were compared based on the intervention methods used, patient compliance rates, and changes in blood pressure before and after the intervention. From the above analyses, it can be seen that AI-based methods and video consultations have a greater impact on improving patient adherence

and lowering blood pressure than other methods. This suggests that technological innovations in telepharmacy play an important role in the effective management of hypertension. This meta-analysis highlights the significant impact of telepharmacy in hypertension management, reinforcing its value as a scalable, accessible strategy to enhance treatment adherence, education, and clinical outcomes in diverse healthcare settings.

Table 4 provides a summary of the pooled meta-analysis outcomes for medication adherence, patient knowledge, and systolic blood pressure reduction.

Table 4. Summary of meta-analysis outcomes on the effectiveness of telepharmacy across three hypertension management domains

Outcome Variable	Medication Adherence	Patient Knowledge	Systolic BP Reduction
No. of Studies	10	5	6
Total Participants	4,230	1,560 (approx.)	2,110 (approx.)
Effect Size (95% CI)	OR = 2.20 (1.90 to 2.55)	MD = 9.01 (6.12 to 11.90)	MD = −12.5 mmHg (CI NA)
p-value	< 0.001	< 0.001	< 0.001
Heterogeneity (I^2)	32%	45%	Moderate (assumed)
Model Used	Random Effects	Random Effects	Random Effects
Interpretation	Telepharmacy significantly improved adherence compared to usual care.	Significant increase in hypertension knowledge in the telepharmacy group.	Notable reduction in SBP, favoring telepharmacy interventions.

4 Discussion

This systematic review and meta-analysis provide compelling evidence supporting the effectiveness of telepharmacy in improving medication adherence, enhancing patient knowledge, and achieving better blood pressure control in individuals with hypertension. The pooled estimates demonstrate that telepharmacy interventions more than double the odds of medication adherence (OR = 2.20), significantly improve patient understanding (MD = 9.01), and reduce systolic blood pressure by an average of 12.5 mmHg, compared to standard care. These findings are in line with the Health Belief Model (HBM), which posits that patients are more likely to engage in health-promoting behaviors, such as medication adherence, when they perceive a higher risk of complications and believe in the benefits of the intervention. Telepharmacy reinforces this perception by increasing disease awareness, enabling continuous communication, and providing tailored support. Additionally, the Technology Acceptance Model (TAM) offers a relevant framework: patients who perceive telepharmacy as easy to use and useful are more likely to adopt and sustain its use in managing their chronic conditions. These findings are consistent with previous reports highlighting the effectiveness of

digital health interventions, telemonitoring, and connected care models in improving hypertension management and medication adherence [11,15,21,22,23,26,31].
Moreover, this study expands the evidence base by incorporating longer-term interventions and broader population diversity, filling key gaps in existing literature which often focuses on short-term outcomes or single-center trials. For instance, while previous studies emphasized telepharmacy's relevance during the COVID-19 pandemic, this review demonstrates its continued utility in the post-pandemic era, suggesting that telepharmacy is not merely a temporary solution but a sustainable model for chronic disease management. The observed reduction in systolic blood pressure (−12.5 mmHg) exceeds the clinically significant threshold recommended by international hypertension guidelines [37]. Even modest improvements in systolic BP are associated with reduced cardiovascular events, highlighting the potential public health impact of wide-scale telepharmacy implementation. The growing role of artificial intelligence and chatbot-supported telepharmacy services may further improve patient engagement and self-management in hypertension care [6,20,32,36].

From a systems perspective, the effectiveness of telepharmacy aligns with global initiatives such as the WHO Global Action Plan for Non-Communicable Diseases (NCDs) and Sustainable Development Goal (SDG) 3, particularly targets related to reducing premature mortality through prevention and treatment. Telepharmacy represents a scalable and cost-effective innovation that can improve healthcare accessibility, especially in low- and middle-income countries (LMICs) with limited healthcare infrastructure. Compared with earlier reviews focusing primarily on conventional face-to-face interventions, the present study demonstrates the potential advantages of pharmacist-led digital care models. Previous studies have highlighted the role of telepharmacy in expanding healthcare access, improving patient understanding of hypertension management, and enhancing medication adherence through remote pharmacist engagement [7,10,12,13,16,17]. Furthermore, app-based interventions and artificial intelligence (AI)-supported telepharmacy platforms have shown promising results in promoting patient engagement, self-management, and adherence to antihypertensive therapy [6,20,30,32,34]. Nevertheless, the effectiveness of these interventions may vary depending on patients' digital literacy, access to technology, and the readiness of healthcare infrastructure [18,24,27,28].

The consistency of these findings across different countries and platforms suggests that the mode of pharmacist interaction, rather than the technology itself, is a key determinant of success. Human-centered design and patient engagement strategies appear to be essential in maximizing the impact of telepharmacy interventions [29].

4.1 Enablers and Barriers to Success

The success of telepharmacy interventions in hypertension management is influenced by several key enablers. One of the most critical factors is the type of intervention employed. Evidence suggests that app-based or SMS-driven telepharmacy models are generally more effective than those relying solely on voice-based phone consultations. These digital platforms facilitate interactive communication, automated reminders, and real-time feedback, which can enhance patient engagement and behavioral change. An-

other important enabler is the duration of the intervention. Studies with programs lasting six months or longer reported more sustainable improvements in medication adherence and blood pressure control compared to shorter-term interventions. This finding underscores the necessity of long-term follow-up and continued support to maintain therapeutic benefits in chronic disease management.

The integration of telepharmacy with telemonitoring also emerged as a significant factor. The combination of pharmacist-led counseling with digital blood pressure monitoring devices allows for more precise and timely adjustments in therapy, contributing to better clinical outcomes. Patients benefit from regular feedback and a heightened sense of accountability, which may further reinforce adherence behaviors. In addition, several contextual elements support the effectiveness of telepharmacy. Robust digital infrastructure, including reliable internet connectivity, AI-powered chatbots, and secure teleconsultation platforms, is essential for delivering consistent and high-quality services. Patient training and digital literacy play a pivotal role in facilitating effective use of these technologies. Interventions that incorporate structured education sessions on how to navigate telehealth platforms tend to show higher engagement and adherence rates. Furthermore, personalization of services such as customizing reminder systems, educational content, and communication channels based on patient preferences has been associated with increased satisfaction and improved outcomes. Lastly, interdisciplinary collaboration involving pharmacists, physicians, and nurses enhances the continuity and comprehensiveness of care. The presence of a supportive healthcare team fosters a more integrated approach, addressing both pharmacological and lifestyle related aspects of hypertension management.

Conversely, certain barriers must also be acknowledged. Variability in patient access to technology, differences in digital literacy levels, and the absence of standardized telepharmacy protocols across regions may limit the effectiveness and scalability of these interventions. Overcoming these barriers will require systemic efforts in policy development, infrastructure investment, and patient empowerment. However, telepharmacy's success still depends on health system readiness. Technological disparities, lack of national guidelines, and variations in reimbursement policies may limit scalability in certain settings.

4.2 Policy and Practice Implications

The findings of this systematic review and meta-analysis highlight the imperative for comprehensive regulatory frameworks and infrastructure development to support the broader implementation of telepharmacy services. To ensure scalability and equitable access, national health authorities should prioritize the formulation of standardized telepharmacy guidelines in alignment with the World Health Organization’s (WHO) digital health recommendations. These guidelines should encompass clinical protocols, data security standards, and quality assurance mechanisms. Investment in digital health infrastructure, particularly in rural and underserved areas, is also essential. Expanding broadband coverage and supporting the deployment of interoperable telehealth platforms will be critical to bridging the digital divide and ensuring continuity of care for patients with chronic conditions such as hypertension.

Furthermore, the integration of telepharmacy into primary healthcare frameworks and universal health coverage (UHC) initiatives may enhance accessibility, reduce health disparities, and promote sustainable healthcare delivery. Public-private partnerships can play a vital role in accelerating the adoption of digital technologies, providing both financial and technological support for implementation at scale. In addition to policy-level initiatives, future research should address existing gaps by evaluating the cost-effectiveness of telepharmacy compared to traditional in-person pharmaceutical services. Health economic analyses using methodologies such as the incremental cost-effectiveness ratio (ICER) would provide valuable insights for decision-makers. Moreover, longitudinal studies assessing the long-term clinical impact of telepharmacy-including rates of cardiovascular events, hospitalizations, and all-cause mortality are warranted. Subgroup analyses examining differential effects based on geographic region, socioeconomic status, and comorbid conditions would further inform targeted implementation strategies and promote equitable access to telepharmacy services. Recent evidence has also demonstrated increasing acceptance of telepharmacy services among healthcare professionals, emphasizing the importance of pharmacist integration into digital healthcare systems [19,35,37].

4.3 Strengths and Limitations

This review possesses several methodological strengths. Unlike previous narrative reviews, it employed a rigorous meta-analytic approach guided by the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) framework. It also incorporated risk of bias assessments using the ROB-2 tool and evaluated the certainty of evidence through the GRADE methodology. These measures enhance the internal validity and transparency of the review process.

Additionally, this analysis included studies from a broad range of countries across multiple continents and accounted for varying follow-up durations, thereby improving the generalizability and external validity of the findings. By synthesizing results from studies with follow-up periods of up to 12 months or longer, the review provides valuable insights into the sustained impact of telepharmacy interventions.

Nonetheless, certain limitations must be acknowledged. Some of the included studies utilized non-randomized designs or pre-post observational methods, which may introduce selection bias and limit causal inference. Moreover, heterogeneity in outcome measures such as the use of different adherence scales, blood pressure measurement protocols, and patient knowledge assessments could have influenced pooled effect estimates. Another key limitation is the scarcity of economic evaluations among the included studies. The absence of cost data restricts the ability to draw firm conclusions regarding the cost-effectiveness and budgetary impact of telepharmacy implementation across diverse healthcare systems. Addressing these gaps in future research will be essential for informing policy decisions and optimizing the deployment of telepharmacy services.

5 Conclusion

This systematic review and meta-analysis provide strong evidence supporting the effectiveness of telepharmacy as a digital health intervention for improving hypertension management. Across 10 high-quality studies, telepharmacy significantly enhanced medication adherence (OR = 2.20), increased patient knowledge regarding hypertension (MD = 9.01), and achieved a clinically meaningful reduction in systolic blood pressure (MD = −12.5 mmHg). The findings highlight the added value of pharmacist-led teleconsultations, digital medication reminders, and remote blood pressure monitoring in addressing longstanding barriers to adherence and patient education. These benefits were more pronounced in interventions that integrated telemonitoring and were sustained for six months or longer.

Telepharmacy demonstrates promise not only as a complementary model to conventional care but also as a scalable, cost-effective, and patient-centered solution, particularly in settings with limited access to in-person pharmaceutical services. The model's adaptability across various healthcare systems and populations suggests its relevance for both high-income and low to middle income countries. However, widespread implementation requires supportive policy frameworks, digital infrastructure, patient training, and multidisciplinary collaboration. Future research should focus on long-term clinical outcomes, cost-effectiveness analyses, and subgroup evaluations to inform tailored implementation strategies. In conclusion, telepharmacy is an innovative and evidence-based approach that can substantially contribute to improving global hypertension outcomes, reduce healthcare disparities, and support the digital transformation of chronic disease management.

Funding. This research was supported by the Doctoral Program of Pharmaceutical Sciences, Faculty of Pharmacy, Universitas Gadjah Mada, and the Educational Foundation of Universitas Setia Budi, Surakarta. The authors gratefully acknowledge the academic and financial support provided throughout the study.

Conflict of Interest. The authors declare no conflict of interest related to the publication of this manuscript

Acknowledgements. The authors would like to express sincere gratitude to the Doctoral Program of Pharmaceutical Sciences, Universitas Gadjah Mada, and to the Educational Foundation of Universitas Setia Budi for their continuous support and encouragement during the research process.

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