The Role of Artificial Intelligence in Enhancing Medication Adherence: A Mini Review

Muhammad Thesa Ghozali
School of Pharmacy, Faculty of Medicine and Health Sciences, Universitas Muhammadiyah Yogyakarta, Special Region of Yogyakarta, Indonesia
E-mail: ghozali@umy.ac.id

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Abstract: *Medication adherence is essential for optimal healthcare outcomes, particularly in managing chronic conditions like diabetes, hypertension, and cardiovascular diseases. Despite its significance, nonadherence remains a widespread issue, contributing to disease progression, hospitalizations, and increased mortality. Traditional interventions such as patient education and reminders have shown limited scalability and efficacy. This review explores the transformative potential of artificial intelligence (AI) in enhancing medication adherence, synthesizing evidence from peer-reviewed studies. AI tools, including mobile applications, wearable devices, ingestible biosensors, and platforms like AiCure, provide personalized, real-time monitoring and tailored interventions to support adherence. These technologies demonstrate significant improvements in adherence rates and patient engagement, especially for chronic and complex conditions. However, challenges such as data privacy concerns, digital literacy gaps, and integration barriers with existing healthcare systems hinder widespread adoption. Addressing these challenges through robust regulatory frameworks, enhanced accessibility, and system interoperability is critical. Future directions include leveraging advancements in reinforcement learning, explainable AI, and collaborative initiatives to ensure equitable and effective use of AI in adherence management. AI offers a promising pathway to improve adherence outcomes and healthcare efficiency, provided ethical, infrastructural, and accessibility challenges are adequately addressed.*

INTRODUCTION

Medication adherence, defined as the degree to which a patient's behavior aligns with prescribed medical instructions regarding medication intake, timing, dosage, and duration, is a

cornerstone of effective healthcare delivery. Adherence is critical for achieving optimal patient outcomes, particularly in managing chronic diseases such as diabetes, hypertension, and cardiovascular conditions. However, nonadherence remains a pervasive and complex issue, with studies indicating that 30–50% of patients with chronic conditions fail to adhere to their prescribed regimens (Abdulsalim et al., 2018). This behavior exacerbates disease progression, increases the risk of hospitalizations, and elevates mortality rates (Chun-Yun Kang, 2022; Muhammad Thesa Ghozali, 2024b).

Role of Technology in Addressing Adherence Issues

Historically, interventions to improve medication adherence have included patient education, verbal counseling, and simple reminder systems. While these approaches have shown moderate success, their scalability and adaptability are limited. Furthermore, these interventions often fail to address the underlying behavioral, social, and systemic factors that contribute to nonadherence (Almutairi, Hosseinzadeh, and Gopaldasani, 2020; Alsalman, Ali, Alnosaier, Alotaibi, and Alanzi, 2021; Alvarado et al., 2017). Technological advancements, particularly in digital health, have introduced new possibilities for improving adherence. Tools such as mobile health (mHealth) applications, wearable devices, and electronic smart pill dispensers offer real-time tracking and personalized reminders, enhancing the feasibility of long-term adherence strategies (Muhammad Thesa Ghozali, 2023; Zisanur Rahman et al., 2022).

Artificial Intelligence (AI) techs have emerged as a game-changing technology in healthcare, offering innovative solutions for adherence challenges. AI-driven systems can analyze patient data to predict adherence behaviors, identify at-risk populations, and deliver tailored interventions. Platforms like AiCure leverage facial recognition technology to confirm medication ingestion, addressing adherence issues in patients with chronic and complex conditions (Abas et al., 2024). Despite their potential, these technologies face significant barriers, including concerns about data privacy, patient trust, and integration into existing healthcare systems (Eleyan, Othman, and Eleyan, 2020; Muhammad Thesa Ghozali, 2024a).

This review aims to examine the transformative potential of AI in improving medication adherence by synthesizing recent evidence from peer-reviewed studies. Specifically, it seeks to: (1) identify AI tools and technologies employed in adherence interventions, (2) evaluate their clinical and economic effectiveness, and (3) discuss challenges and future opportunities for integrating AI into adherence strategies.

METHODOLOGY

Database and Search Strategy

This review employed the Scopus online database, a multidisciplinary and widely recognized repository of peer-reviewed literature, as the primary source for identifying relevant studies. SCOPUS was chosen for its extensive indexing of high-impact journals, providing access to a comprehensive range of articles across healthcare, technology, and behavioral sciences. To ensure a thorough exploration of the intersection between artificial intelligence (AI) and medication adherence, a targeted search string was developed as follows: ("medication adherence" OR "medication compliance" OR "treatment adherence" OR "drug adherence") AND ("artificial intelligence" OR "AI" OR "machine learning" OR "deep learning") AND ("healthcare" OR "health" OR "patient" OR "clinical") AND ("technology" OR "innovation" OR "intervention" OR "support") AND ("behavior" OR "engagement" OR "motivation" OR "outcome").

The search included peer-reviewed studies indexed in Scopus up to January 2025, with results restricted to articles published in English. This strategy ensured the identification of a diverse range of studies focused on AI-driven interventions to enhance medication adherence.

Inclusion and Exclusion Criteria

To ensure the selection of high-quality and relevant studies, both predefined inclusion and exclusion criteria were established (Table 1). These criteria focused on publication type, study population, intervention scope, language, and outcome measures.

Table 1. Eligible Criteria of the Study

Criterion	Inclusion Criteria	Exclusion Criteria
Publication Type	Peer-reviewed articles, systematic reviews, meta-analyses, and randomized controlled trials (RCTs).	Editorials, conference abstracts, case reports, and unpublished materials.
Study Population	Studies involving patients across all age groups and healthcare settings.	Studies focused on animal models or in vitro analyses.
Focus of Intervention	AI-based interventions aimed at improving medication adherence in healthcare settings.	Non-AI interventions (e.g., traditional counseling or manual reminders).
Language	Articles published in English.	Articles published in languages other than English.
Outcome Measures	Studies reporting outcomes such as adherence rates, clinical outcomes, patient engagement, or cost-effectiveness.	Studies lacking specific outcomes or focused solely on technology development without adherence app.

Data Analysis

A systematic thematic analysis was conducted to extract and synthesize the findings from the selected studies. Articles were reviewed and categorized based on the type of AI tech intervention, technological approach, and targeted health conditions. Key themes, including predictive modeling, real-time adherence monitoring, and personalized patient engagement strategies, were identified. Furthermore, studies were stratified by reported outcome measures such as adherence rates, clinical improvements, and patient-reported experiences. This analytical approach facilitated the identification of recurring patterns, gaps in existing literature, and variations in the effectiveness of AI-driven adherence interventions.

RESULTS AND DISCUSSION

Artificial Intelligence (AI) Tools and Technologies in Medication Adherence

AI system has emerged as a pivotal technology in addressing the challenges of medication adherence, leveraging innovative tools to enhance patient outcomes. Mobile applications and AI-driven reminder systems are among the most accessible interventions, designed to assist patients in adhering to prescribed medication regimens. These applications incorporate features such as scheduled reminders, intake tracking, and educational content, providing patients with personalized support to ensure consistent medication use. Evidence suggests that these tools

significantly improve adherence, particularly in managing chronic conditions where long-term compliance is critical (Rammal, Alomar, and Palaian, 2024). Table 2 represents a summary of selected studies.

Table 2. A General Summary of Selected Studies

Author (s)	Focus Area	Key Findings	Methodologies	Population	Limitations
(Babel, Taneja, Mondello Malvestiti, Monaco, and Donde, 2021)	Precision medicine and AI in personalized healthcare	AI provides personalized interventions, improving adherence and patient engagement.	Review of AI-driven personalized healthcare tools	Patients requiring personalized treatment	Limited focus on socio-economic barriers
(G**ackowski, Jasińska-Stroschein, Osmałek, and Waszyk-Nowaczyk, 2024)**	Medication adherence and its challenges	Medication adherence is critical but often overlooked, leading to poor outcomes.	Literature review on adherence issues and barriers	Patients across various chronic conditions	No evaluation of emerging AI technologies
(M.T. Ghozali, 2024)	AI solutions for medication adherence in chronic diseases	AI platforms, including IoT devices, enhance adherence in non-communicable diseases.	Review of IoT and AI applications	Patients with chronic diseases	High costs and limited accessibility of tools
(Gupta, Mohanty, Behera, and Nayak, 2024)	Applications of AI in healthcare	AI integration improves patient monitoring and decision-making in healthcare.	Review of AI advancements in healthcare	General healthcare systems	Focused mainly on technological potential
(Merino-Barbancho et al., 2023)	Convergence of human intelligence and AI in healthcare	High-performance AI tools enhance efficiency and adherence in medical practices.	Exploratory review of AI integration in healthcare	Providers and patients	Ethical concerns and scalability challenges

(Rammal et al., 2024)	AI in improving health outcomes	Personalized AI-driven tools improve treatment adherence and outcomes in chronic disease management.	Evidence-based analysis of precision medicine with AI	Patients with chronic and complex diseases	Lack of data on long-term adherence effects
(Tantray, Patel, Wani, Kosey, and Prajapati, 2024)	Historical and future perspectives on AI in healthcare	AI technologies offer transformative potential for healthcare efficiency and medication adherence.	Comprehensive review of past and emerging AI trends	Healthcare providers and systems	Limited focus on specific adherence challenges

Ingestible biosensors are another example of AI-powered innovation, enabling real-time monitoring of medication ingestion. All these sensors transmit data to paired devices, confirming whether a patient has taken their prescribed dose. This approach provides unparalleled accuracy in adherence monitoring, particularly in clinical trials and high-risk patient populations. However, the cost and limited accessibility of these technologies present significant barriers to widespread adoption, particularly in resource-limited settings (Babel et al., 2021). Meanwhile, the AI-driven platforms, such as AiCure, utilize visual recognition technology to confirm medication ingestion, offering a practical solution for complex treatment regimens. This technology has been particularly effective in improving adherence in patients managing chronic diseases like hepatitis C and heart failure. By providing a visual verification mechanism, these platforms enable healthcare providers to closely monitor patients at risk of non-adherence, improving therapeutic outcomes and reducing complications (Gackowski et al., 2024). Finally, wearable devices and Internet of Things (IoT) systems represent another dimension of AI integration in adherence management. These technologies facilitate continuous monitoring of patient behaviors, such as medication intake, through biosensors and behavioral analytics. AI algorithms process the collected data to identify deviations from prescribed regimens, enabling timely interventions. The combination of real-time data analysis and IoT connectivity has proven particularly valuable in managing conditions requiring strict adherence, such as diabetes and hypertension (M.T. Ghozali, 2024).

Challenges and Considerations

Despite its transformative potential, the integration of AI systems into medication adherence management poses several challenges. Foremost among these are concerns regarding data privacy and security. AI systems require access to sensitive patient information, including health records and biometric data, which raises concerns about confidentiality and misuse. Ensuring compliance with data protection regulations, such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA), is

essential to mitigate these risks (Allan, Webster, Chambers, and Nott, 2021; Muhammad Thesa Ghozali, Mohany, Milošević, Satibi, and Kurniawan, 2023; Tantray et al., 2024). Moreover, user characteristics, including age, digital literacy, and health literacy, also influence the effectiveness of AI-based adherence tools. Older adults or individuals unfamiliar with digital technologies may face difficulties in navigating AI platforms, potentially exacerbating disparities in healthcare outcomes. Designing user-friendly interfaces and providing training resources are critical to ensuring equitable access to AI technologies (Abdul Rahim and Thomas, 2017; Adje et al., 2022; Alsalman et al., 2021). Additionally, the integration of AI tools into existing healthcare systems presents another significant barrier. Many healthcare providers lack the infrastructure and technical expertise required to implement advanced AI solutions. Additionally, interoperability between AI platforms and electronic health records (EHRs) remains a persistent challenge, hindering the seamless adoption of these technologies (Amin et al., 2023; Chekroud et al., 2021; Giuste et al., 2023).

Benefits of AI in Enhancing Medication Adherence

AI has demonstrated numerous benefits in enhancing medication adherence, with improved communication between patients and healthcare providers being among the most notable. AI-powered platforms facilitate seamless communication, ensuring that patients understand the intricacies of their treatment regimens and the importance of adherence. For instance, virtual assistants powered by natural language processing (NLP) can provide immediate responses to patient queries, reducing misunderstandings and fostering a supportive treatment environment (Gupta et al., 2024). Additionally, the ability of AI to provide personalized interventions is a key advantage over traditional adherence strategies. By analyzing patient-specific data, such as medical history, behavioral patterns, and lifestyle factors, AI algorithms can develop tailored adherence strategies. These personalized interventions are significantly more effective than generic approaches, particularly in high-risk populations. For example, patients prone to missing doses may receive more frequent reminders and motivational content, improving compliance and overall health outcomes (Merino-Barbancho et al., 2023). Moreover, real-time monitoring and feedback mechanisms are another major benefit of AI in adherence management. AI systems can continuously track adherence behaviors, identify non-compliance patterns, and provide immediate feedback to both patients and healthcare providers. This proactive approach enables early interventions to address barriers to adherence, reducing the likelihood of adverse outcomes. For instance, in diabetes management, AI tools integrate glucose monitoring with medication adherence support, enabling dynamic treatment adjustments and reducing hospitalizations (Rammal et al., 2024).

Challenges and Considerations

Despite its transformative potential, the integration of AI into medication adherence management poses several challenges. Foremost among these are concerns regarding data privacy and security. AI systems require access to sensitive patient information, including health records and biometric data, which raises concerns about confidentiality and misuse. Ensuring compliance with data protection regulations, such as the General Data Protection Regulation (GDPR) and the Health Insurance Portability and Accountability Act (HIPAA), is essential to mitigate these risks (Bonab et al., 2006; Ghoreishi, Vahedian-Shahroodi, Jafari, and Tehranid, 2019; Kavakiotis et al., 2017). Meanwhile, user characteristics, including age, digital literacy, and health literacy, also influence the effectiveness of AI-based adherence tools. Older adults or individuals unfamiliar with digital

technologies may face difficulties in navigating AI platforms, potentially exacerbating disparities in healthcare outcomes. Designing user-friendly interfaces and providing training resources are critical to ensuring equitable access to AI technologies (Bajorath et al., 2022; Bajwa, Munir, Nori, and Williams, 2021; Balcombe, 2023).The integration of AI tools into existing healthcare systems presents another significant barrier. Many healthcare providers lack the infrastructure and technical expertise required to implement advanced AI solutions. Additionally, interoperability between AI platforms and electronic health records (EHRs) remains a persistent challenge, hindering the seamless adoption of these technologies (Catho et al., 2021; Chekroud et al., 2021; Chiu et al., 2024).

Future Directions

The future of AI in medication adherence lies in advancing its technological capabilities and ensuring equitable access. Emerging innovations, such as reinforcement learning and explainable AI, hold promise for improving the adaptability and transparency of AI tools. These technologies will enable dynamic adjustments to adherence interventions based on real-time data, enhancing their effectiveness and reliability (Ghanei Gheshlagh et al., 2015; Horii, Momo, Yasu, Kabeya, and Atsuda, 2019; Karagiannis, Mitsis, and Nikita, 2022). Additionally, efforts to enhance the scalability and accessibility of AI tools are critical for their widespread adoption. Reducing costs and developing solutions tailored to low-resource settings will ensure that the benefits of AI reach underserved populations. Collaborative initiatives involving governments, healthcare organizations, and technology developers are essential to achieving this goal (Alsayed et al., 2023; Green et al., 2022; Meilianti, Smith, Ernawati, Pratita, and Bates, 2021). Finally, the establishment of robust regulatory frameworks will be pivotal in addressing the ethical and legal challenges posed by AI in healthcare. Clear guidelines on data governance, algorithm transparency, and patient consent will foster trust among stakeholders, facilitating the safe and effective use of AI technologies (Alokaily, Almansour, and Aldohbeyb, 2024; Meilianti et al., 2021; Yang et al., 2024).

CONCLUSION

AI has revolutionized the field of medication adherence, introducing innovative tools such as mobile applications, ingestible biosensors, and AI-driven platforms that enhance adherence monitoring, communication, and personalization. These technologies have shown great promise in improving adherence rates and patient outcomes, particularly in managing chronic and complex conditions. However, addressing challenges related to ethical concerns, access disparities, and system integration is essential to unlocking the full potential of AI in healthcare. Continued research, investment in infrastructure, and the development of robust regulatory frameworks are critical to ensuring the equitable and effective adoption of AI-driven adherence interventions.

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REFERENCES

Abas, S. A., Ismail, N., Zakaria, Y., Yasin, S. M., Ibrahim, K., Ismail, I., … Ahmad, N. (2024). Enhancing tuberculosis treatment adherence and motivation through gamified real-time mobile app utilization: A single-arm intervention study. *BMC Public Health*, *24*(1). Scopus. https://doi.org/10.1186/s12889-023-17561-z

Abdul Rahim, M. I., and Thomas, R. H. (2017). Gamification of Medication Adherence in Epilepsy. *Seizure*, *52*, 11–14. Scopus. https://doi.org/10.1016/j.seizure.2017.09.008

Abdulsalim, S., Unnikrishnan, M. K., Manu, M. K., Alrasheedy, A. A., Godman, B., and Morisky, D. E. (2018). Structured pharmacist-led intervention programme to improve medication adherence in COPD patients: A randomized controlled study. *Research in Social & Administrative Pharmacy: RSAP*, *14*(10), 909–914. https://doi.org/10.1016/j.sapharm.2017.10.008

Adje, Y. H., Brooks, K. M., Castillo-Mancilla, J. R., Wyles, D. L., Anderson, P. L., and Kiser, J. J. (2022). The use of technology-based adherence monitoring in the treatment of hepatitis C virus. *Therapeutic Advances in Infectious Disease*, *9*, 20499361221095664. https://doi.org/10.1177/20499361221095664

Allan, J., Webster, E., Chambers, B., and Nott, S. (2021). "This is streets ahead of what we used to do": Staff perceptions of virtual clinical pharmacy services in rural and remote Australian hospitals. *BMC Health Services Research*, *21*(1), 1306. https://doi.org/10.1186/s12913-021-07328-w

Almutairi, N., Hosseinzadeh, H., and Gopaldasani, V. (2020). The effectiveness of patient activation intervention on type 2 diabetes mellitus glycemic control and self-management behaviors: A systematic review of RCTs. *Primary Care Diabetes*, *14*(1), 12–20. https://doi.org/10.1016/j.pcd.2019.08.009

Alokaily, A. O., Almansour, M. J., and Aldohbeyb, A. A. (2024). A Cost-Effective IoT-based Transcutaneous Electrical Nerve Stimulation (TENS): Proof-of-Concept Design and Evaluation. *International Journal of Advanced Computer Science and Applications*, *15*(4), 314–318. Scopus. https://doi.org/10.14569/IJACSA.2024.0150432

Alsalman, D. M., Ali, Z. B., Alnosaier, Z., Alotaibi, N., and Alanzi, T. M. (2021). Caregiver's Opinions on the Design of the Screens of a Future Gamified Mobile Application for Self-Management of Type 1 Diabetes in Children in Saudi Arabia. *International Journal of Telemedicine and Applications*, *2021*. Scopus. https://doi.org/10.1155/2021/8822676

Alsayed, A. O., Ismail, N. A., Hasan, L., Syed, A. H., Embarak, F., and Da'u, A. (2023). A systematic literature review for understanding the effectiveness of advanced techniques in diabetes self-care management. *Alexandria Engineering Journal*, *79*, 274–295. https://doi.org/10.1016/j.aej.2023.08.026

Alvarado, M. M., Kum, H.-C., Gonzalez Coronado, K., Foster, M. J., Ortega, P., and Lawley, M. A. (2017). Barriers to Remote Health Interventions for Type 2 Diabetes: A Systematic Review and Proposed Classification Scheme. *Journal of Medical Internet Research*, *19*(2), e28. https://doi.org/10.2196/jmir.6382

Amin, D., Garzón-Orjuela, N., Agustin Garcia Pereira, Parveen, S., Vornhagen, H., and Vellinga, A. (2023). Artificial Intelligence to Improve Antibiotic Prescribing: A Systematic Review. *Antibiotics*, *12*(8), 1293. ProQuest Central; Publicly Available Content Database (2856762674). https://doi.org/10.3390/antibiotics12081293

Babel, A., Taneja, R., Mondello Malvestiti, F., Monaco, A., and Donde, S. (2021). Artificial Intelligence Solutions to Increase Medication Adherence in Patients With Non-

communicable Diseases. *Frontiers in Digital Health*, *3*. Scopus. https://doi.org/10.3389/fdgth.2021.669869

Bajorath, J., Chávez-Hernández, A. L., Duran-Frigola, M., Fernández-de Gortari, E., Gasteiger, J., López-López, E., … Valli, M. (2022). Chemoinformatics and artificial intelligence colloquium: Progress and challenges in developing bioactive compounds. *Journal of Cheminformatics*, *14*(1), 82. https://doi.org/10.1186/s13321-022-00661-0

Bajwa, J., Munir, U., Nori, A., and Williams, B. (2021). Artificial intelligence in healthcare: Transforming the practice of medicine. *Future Healthcare Journal*, *8*(2), e188. https://doi.org/10.7861/fhj.2021-0095

Balcombe, L. (2023). AI Chatbots in Digital Mental Health. *Informatics*, *10*(4), 82. https://doi.org/10.3390/informatics10040082

Bonab, M. M., Alimoghaddam, K., Talebian, F., Ghaffari, S. H., Ghavamzadeh, A., and Nikbin, B. (2006). Aging of mesenchymal stem cell in vitro. *BMC Cell Biology*, *7*, 14. https://doi.org/10.1186/1471-2121-7-14

Catho, G., Centemero, N. S., Waldispühl Suter, B., Vernaz, N., Portela, J., Da Silva, S., … The COMPASS Study Group. (2021). How to Develop and Implement a Computerized Decision Support System Integrated for Antimicrobial Stewardship? Experiences From Two Swiss Hospital Systems. *Frontiers in Digital Health*, *2*. https://doi.org/10.3389/fdgth.2020.583390

Chekroud, A. M., Bondar, J., Delgadillo, J., Doherty, G., Wasil, A., Fokkema, M., … Choi, K. (2021). The promise of machine learning in predicting treatment outcomes in psychiatry. *World Psychiatry*, *20*(2), 154–170. https://doi.org/10.1002/wps.20882

Chiu, L.-W., Ku, Y.-E., Chan, F.-Y., Lie, W.-N., Chao, H.-J., Wang, S.-Y., … Chen, H.-Y. (2024). Machine learning algorithms to predict colistin-induced nephrotoxicity from electronic health records in patients with multidrug-resistant Gram-negative infection. *International Journal of Antimicrobial Agents*, *64*(1), 107175. https://doi.org/10.1016/j.ijantimicag.2024.107175

Chun-Yun Kang, G. (2022). Technology-based interventions to improve adherence to antihypertensive medications – An evidence-based review. *Digital Health*, *8*, 20552076221089725. https://doi.org/10.1177/20552076221089725

Eleyan, D., Othman, A., and Eleyan, A. (2020). Enhancing Software Comments Readability Using Flesch Reading Ease Score. *Information*, *11*(9), 430. https://doi.org/10.3390/info11090430

Gackowski, M., Jasińska-Stroschein, M., Osmałek, T., and Waszyk-Nowaczyk, M. (2024). Innovative Approaches to Enhance and Measure Medication Adherence in Chronic Disease Management: A Review. *Medical Science Monitor*, *30*. Scopus. https://doi.org/10.12659/MSM.944605

Ghanei Gheshlagh, R., Ebadi, A., Veisi Raygani, A. K., Nourozi Tabrizi, K., Dalvandi, A., and Mahmoodi, H. (2015). Determining Concurrent Validity of the Morisky Medication Adherence Scale in Patients with Type 2 Diabetes. *Iranian Journal of Rehabilitation Research*, *1*(3), 24–32.

Ghoreishi, M.-S., Vahedian-Shahroodi, M., Jafari, A., and Tehranid, H. (2019). Self-care behaviors in patients with type 2 diabetes: Education intervention base on social cognitive theory. *Diabetes & Metabolic Syndrome: Clinical Research & Reviews*, *13*(3), 2049–2056.

Ghozali, M.T. (2024). Predicting Patient Adherence in Healthcare using Artificial Intelligence and Machine Learning Techniques: A Narrative Review. *Int. Conf. I-SMAC (IoT Soc.,*

Mob., Anal. Cloud), I-SMAC - Proc., 1211–1215. Institute of Electrical and Electronics Engineers Inc. Scopus. https://doi.org/10.1109/I-SMAC61858.2024.10714843

Ghozali, Muhammad Thesa. (2023). Is integrating video into tech-based patient education effective for improving medication adherence? – A review. *Paladyn, Journal of Behavioral Robotics*, *14*(1). https://doi.org/10.1515/pjbr-2022-0109

Ghozali, Muhammad Thesa. (2024a). Assessment of knowledge, perception, and readiness for telepharmacy-assisted pharmaceutical services among young pharmacists in rural Indonesia. *Exploratory Research in Clinical and Social Pharmacy*, *16*, 100513. https://doi.org/10.1016/j.rcsop.2024.100513

Ghozali, Muhammad Thesa. (2024b). *Buku Ajar Sistem Informasi Manajemen untuk Farmasi*. Yogyakarta, Indonesia: Deepublish.

Ghozali, Muhammad Thesa, Mohany, M., Milošević, M., Satibi, and Kurniawan, M. (2023). Impact of a mobile-app assisted self-management educational intervention on the scores of asthma control test (ACT) questionnaire among young asthmatic patients. *Research in Social and Administrative Pharmacy*, *19*(10), 1354–1359. https://doi.org/10.1016/j.sapharm.2023.06.001

Giuste, F., Shi, W., Zhu, Y., Naren, T., Isgut, M., Sha, Y., … Wang, M. D. (2023). Explainable Artificial Intelligence Methods in Combating Pandemics: A Systematic Review. *IEEE Reviews in Biomedical Engineering*, *16*, 5–21. Scopus. https://doi.org/10.1109/RBME.2022.3185953

Green, A. G., Yoon, C. H., Chen, M. L., Ektefaie, Y., Fina, M., Freschi, L., … Farhat, M. (2022). A convolutional neural network highlights mutations relevant to antimicrobial resistance in Mycobacterium tuberculosis. *Nature Communications*, *13*(1), 3817. https://doi.org/10.1038/s41467-022-31236-0

Gupta, S., Mohanty, S., Behera, D. K., and Nayak, S. R. (2024). AI enhanced healthcare: Opportunities, challenges, ethical considerations, and future risk. In *Responsible and Explainable Artificial Intelligence in Healthc.: Ethics and Transpar. At the Intersection* (pp. 127–153). Elsevier. Scopus. https://doi.org/10.1016/B978-0-443-24788-0.00006-6

Horii, T., Momo, K., Yasu, T., Kabeya, Y., and Atsuda, K. (2019). Determination of factors affecting medication adherence in type 2 diabetes mellitus patients using a nationwide claim-based database in Japan. *PLOS ONE*, *14*(10), e0223431. https://doi.org/10.1371/journal.pone.0223431

Karagiannis, D., Mitsis, K., and Nikita, K. S. (2022). Development of a Low-Power IoMT Portable Pillbox for Medication Adherence Improvement and Remote Treatment Adjustment. *Sensors*, *22*(15), 5818. https://doi.org/10.3390/s22155818

Kavakiotis, I., Tsave, O., Salifoglou, A., Maglaveras, N., Vlahavas, I., and Chouvarda, I. (2017). Machine Learning and Data Mining Methods in Diabetes Research. *Computational and Structural Biotechnology Journal*, *15*, 104–116. https://doi.org/10.1016/j.csbj.2016.12.005

Meilianti, S., Smith, F., Ernawati, D. K., Pratita, R. N., and Bates, I. (2021). A country-level national needs assessment of the Indonesian pharmacy workforce. *Research in Social and Administrative Pharmacy*, *17*(11), 1989–1996. https://doi.org/10.1016/j.sapharm.2021.03.003

Merino-Barbancho, B., Arroyo, P., Rujas, M., Cipric, A., Ciccone, N., Lupiáñez-Villanueva, F., … Fico, G. (2023). Multi-stakeholder Approach for Designing an AI Model to Predict Treatment Adherence. In Duffy V.G. (Ed.), *Lect. Notes Comput. Sci.*: *Vol. 14029 LNCS*

(pp. 260–271). Springer Science and Business Media Deutschland GmbH. Scopus. https://doi.org/10.1007/978-3-031-35748-0_19

Rammal, D. S., Alomar, M., and Palaian, S. (2024). AI-Driven pharmacy practice: Unleashing the revolutionary potential in medication management, pharmacy workflow, and patient care. *Pharmacy Practice*, *22*(2). Scopus. https://doi.org/10.18549/PharmPract.2024.2.2958

Tantray, J., Patel, A., Wani, S. N., Kosey, S., and Prajapati, B. G. (2024). Prescription Precision: A Comprehensive Review of Intelligent Prescription Systems. *Current Pharmaceutical Design*, *30*(34), 2671–2684. Scopus. https://doi.org/10.2174/0113816128321623240719104337

Yang, X., Yang, X., Jiang, W., Luo, N., Hu, Y., Yang, Y., … Lin, J. (2024). A cross-sectional investigation of factors influencing mpox vaccine hesitancy for students in Southwest China. *Human Vaccines & Immunotherapeutics*, *20*(1), 2309704. https://doi.org/10.1080/21645515.2024.2309704

Zisanur Rahman, A. S. M., Liu, C., Sturm, H., Hogan, A. M., Davis, R., Hu, P., and Cardona, S. T. (2022). A machine learning model trained on a high-throughput antibacterial screen increases the hit rate of drug discovery. *PLoS Computational Biology*, *18*(10). Scopus. https://doi.org/10.1371/journal.pcbi.1010613