ARTIFICIAL INTELLIGENCE-DRIVEN DIGITAL PHARMACEUTICAL SERVICES AND PATIENTS' MEDICATION ADHERENCE: THE MEDIATING ROLE OF PATIENT TRUST AND THE MODERATING EFFECT OF DIGITAL HEALTH LITERACY

Ahmet Canan Elkıran
ahmetelkiran@icloud.com

Assoc. Prof. Dr. Azmiye Yınal
azmiyeyinal@onbeskku.edu.tr
0000-0002-7820-1553

Assoc. Prof. Dr. Figen Yaman Lesinger
flesinger@eul.edu.tr

ABSTRACT
Artificial intelligence (AI) is increasingly integrated into pharmaceutical services through intelligent prescription systems, medication reminders, and personalized counseling platforms. This study examines the effect of Artificial Intelligence-Driven Digital Pharmaceutical Services on Patients' Medication Adherence and investigates the mediating role of Patient Trust and the moderating effect of Digital Health Literacy. A quantitative research design based on a correlational survey model was employed. Data were collected between March and May 2026 from 475 individuals receiving services from community pharmacies in the İskele region of the Turkish Republic of Northern Cyprus (TRNC) and analyzed using IBM SPSS Statistics 29.0 and AMOS 24.0. The findings revealed that AI-driven digital pharmaceutical services have a significant positive effect on medication adherence and constitute its strongest predictor. Patient Trust partially mediated this relationship, while Digital Health Literacy significantly moderated it, indicating stronger effects among patients with higher digital competencies. The study provides practical implications for pharmacists, healthcare managers, and policymakers seeking to improve medication adherence through AI-supported pharmaceutical care.
Key Words: Artificial Intelligence, Digital Pharmaceutical Services, Medication Adherence, Patient Trust, Digital Health Literacy, Community Pharmacy, TRNC.

Introduction

The rapid advancement of artificial intelligence (AI) has significantly transformed healthcare delivery by improving the accessibility, efficiency, and quality of healthcare services. Among healthcare sectors, pharmaceutical services have increasingly integrated AI-supported technologies, including intelligent prescription systems, medication reminder applications, virtual health assistants, predictive analytics, and personalized patient counseling platforms. These innovations enable pharmacists to provide more accurate medication management, reduce medication errors, enhance patient engagement, and improve treatment outcomes. Consequently, AI-driven digital pharmaceutical services have become an important component of digital health transformation worldwide (Topol, 2019; Davenport & Kalakota, 2019; World Health Organization [WHO], 2024).

Digital pharmaceutical services refer to the application of digital technologies that facilitate communication between pharmacists and patients throughout the medication management process. Artificial intelligence has further expanded these services by enabling personalized medication recommendations, automated prescription verification, intelligent drug interaction alerts, and real-time monitoring of medication adherence. Through machine learning algorithms and predictive analytics, AI systems can identify patients at risk of poor medication adherence and provide personalized interventions that support more effective pharmaceutical care. As healthcare systems increasingly emphasize patient-centered care, AI-supported pharmaceutical services have become essential for improving both clinical outcomes and patient satisfaction (European Medicines Agency, 2024; Dwivedi et al., 2023).

Medication adherence remains one of the most significant challenges facing healthcare systems globally. According to the World Health Organization, nearly half of patients with chronic diseases fail to take their medications as prescribed, leading to avoidable hospitalizations, increased healthcare expenditures, disease progression, and reduced quality of life. Poor medication adherence is influenced by multiple factors, including inadequate communication, limited patient education, lack of trust in healthcare providers, and insufficient follow-up. AI-supported pharmaceutical services offer innovative solutions by providing personalized reminders, digital counseling, intelligent monitoring systems, and continuous patient support that encourage patients to follow prescribed treatment regimens more effectively (World Health Organization, 2024; Osterberg & Blaschke, 2005).

 Copyright © The Online Journal of New Horizons in Education

An important psychological factor influencing medication adherence is Patient Trust. Trust reflects patients' confidence in the competence, honesty, and reliability of healthcare professionals and pharmaceutical services. Patients who trust pharmacists and AI-supported healthcare systems are more likely to follow medication instructions, accept pharmaceutical recommendations, and maintain long-term treatment adherence. Artificial intelligence can strengthen patient trust by improving the accuracy, consistency, transparency, and accessibility of pharmaceutical information while facilitating continuous communication between pharmacists and patients (Hall et al., 2001; Birkhäuer et al., 2017).

Another critical determinant of the effectiveness of AI-supported pharmaceutical services is Digital Health Literacy, which refers to individuals' ability to access, understand, evaluate, and effectively use digital health information and technologies. Patients with higher levels of digital health literacy are generally more capable of utilizing AI-supported medication management applications, electronic prescription systems, telepharmacy platforms, and digital pharmaceutical counseling services. Consequently, digital health literacy may strengthen the relationship between AI-driven pharmaceutical services and medication adherence by enabling patients to make informed healthcare decisions and actively participate in their treatment process (Norman & Skinner, 2006; van Kessel et al., 2022).

The Turkish Republic of Northern Cyprus (TRNC) has also experienced substantial growth in the digitalization of healthcare services. Particularly in the İskele region, increasing numbers of community pharmacies have begun utilizing digital pharmaceutical systems, electronic prescriptions, mobile health applications, and AI-supported communication tools to improve patient services. Despite these technological developments, empirical evidence examining how AI-driven digital pharmaceutical services influence patients' medication adherence remains limited within the TRNC healthcare context. Moreover, the roles of Patient Trust and Digital Health Literacy have not yet been comprehensively investigated among pharmacy patients in the region.

Accordingly, this study investigates the effect of Artificial Intelligence-Driven Digital Pharmaceutical Services on Patients' Medication Adherence among pharmacy customers in the İskele region of the Turkish Republic of Northern Cyprus. Furthermore, the study examines the mediating role of Patient Trust and the moderating effect of Digital Health Literacy. Data were collected from 475 participants receiving pharmaceutical services from community pharmacies in the İskele region. By integrating perspectives from artificial intelligence, pharmaceutical care, healthcare communication, and patient behavior, this study contributes to the existing literature while providing practical recommendations for pharmacists, healthcare managers, and policymakers seeking to improve medication adherence through AI-supported pharmaceutical services.

Problem Statement

Artificial intelligence has become an increasingly important component of digital healthcare systems by improving pharmaceutical services, supporting clinical decision-making, and facilitating patient-centered healthcare delivery. AI-supported digital pharmaceutical services, including intelligent prescription management, automated medication reminders, virtual pharmaceutical counseling, and personalized health recommendations, have the potential to improve patients' medication adherence and overall treatment effectiveness. Nevertheless, despite these technological advancements, medication non-adherence remains a major public health concern worldwide, resulting in poor clinical outcomes, unnecessary healthcare costs, and increased disease burden (World Health Organization, 2024; Topol, 2019).

Previous studies have demonstrated that digital pharmaceutical services can positively influence patient behavior by improving communication and increasing access to healthcare information. However, relatively limited empirical evidence explains the mechanisms through which AI-supported pharmaceutical services influence patients' medication adherence. In particular, the role of Patient Trust as a mediating variable remains insufficiently investigated. Since trust represents one of the most important determinants of patients' willingness to accept pharmaceutical recommendations and follow prescribed treatment plans, understanding its mediating function is essential for improving digital pharmaceutical care (Birkhäuer et al., 2017; Hall et al., 2001).

Similarly, patients differ considerably in their ability to use digital healthcare technologies. Individuals with higher levels of Digital Health Literacy are generally better equipped to understand digital health information, evaluate AI-generated recommendations, and utilize mobile health applications effectively. Consequently, Digital Health Literacy may influence the extent to which AI-supported pharmaceutical services improve medication adherence. Despite its theoretical importance, limited research has examined whether digital health literacy strengthens or weakens the effectiveness of AI-driven pharmaceutical services within community pharmacy settings (Norman & Skinner, 2006; van Kessel et al., 2022).

 Copyright © The Online Journal of New Horizons in Education

In the Turkish Republic of Northern Cyprus, community pharmacies have increasingly adopted digital healthcare technologies and electronic pharmaceutical services. This transformation is particularly evident in the İskele region, where pharmacies have expanded the use of electronic prescription systems, digital patient communication platforms, and AI-supported pharmaceutical information services. Nevertheless, no comprehensive empirical study has simultaneously examined the relationships among Artificial Intelligence-Driven Digital Pharmaceutical Services, Patient Trust, Digital Health Literacy, and Patients' Medication Adherence within the TRNC context. This represents an important gap in both pharmaceutical practice and the healthcare management literature.

Therefore, this study addresses this research gap by examining the effect of Artificial Intelligence-Driven Digital Pharmaceutical Services on Patients' Medication Adherence among 475 pharmacy customers in the İskele region of the Turkish Republic of Northern Cyprus. Furthermore, the study investigates the mediating role of Patient Trust and the moderating effect of Digital Health Literacy. The findings are expected to contribute to the literature on artificial intelligence, digital pharmacy, healthcare communication, and patient behavior while providing evidence-based recommendations for pharmacists, healthcare organizations, and policymakers aiming to improve medication adherence through AI-supported pharmaceutical services.

Purpose of the Research

Digital Marketing on consumers' intention to adopt electric vehicles in the Turkish Republic of Northern Cyprus (TRNC). More specifically, the research focuses on potential electric vehicle buyers in Nicosia, Kyrenia, and Famagusta, examining the extent to which AI-powered digital marketing strategies affect their willingness to adopt electric vehicles.

Beyond investigating the direct association between Artificial Intelligence-Driven Digital Marketing and consumers' adoption intention, the study also examines the mediating role of Green Trust and the moderating influence of Environmental Concern. The proposed conceptual model seeks to clarify how AI-enabled digital marketing strategies can build consumer trust in environmentally responsible automotive brands and, consequently, increase consumers' intention to adopt electric vehicles.

Moreover, this research aims to enrich the existing literature by bringing together artificial intelligence, digital marketing, green marketing, consumer behavior, and sustainable transportation within an integrated conceptual framework. The anticipated findings are expected to offer meaningful insights for automobile manufacturers, digital marketing professionals, policymakers, and other organizations working to promote sustainable mobility in the TRNC.

Importance of the Research

The increasing integration of artificial intelligence into healthcare systems has created significant opportunities to improve the accessibility, efficiency, personalization, and quality of pharmaceutical services. AI-driven digital pharmaceutical services, including intelligent medication reminder systems, electronic prescription management, virtual pharmaceutical counseling, and personalized patient communication tools, may support more effective medication management and patient-centered pharmaceutical care. Nevertheless, medication non-adherence remains an important challenge for healthcare systems, particularly among individuals requiring long-term pharmacological treatment. Therefore, investigating the relationship between AI-supported pharmaceutical services and patients' medication adherence is important for both healthcare research and pharmaceutical practice (Topol, 2019; Davenport & Kalakota, 2019; Osterberg & Blaschke, 2005).

From a theoretical perspective, this research contributes to the literature by integrating four interconnected constructs within a unified conceptual framework: Artificial Intelligence-Driven Digital Pharmaceutical Services, Patient Trust, Digital Health Literacy, and Patients' Medication Adherence. Rather than examining only the direct relationship between digital pharmaceutical services and patient behavior, the study investigates Patient Trust as a mediating variable and Digital Health Literacy as a moderating variable. This approach provides a more comprehensive understanding of the psychological and individual factors associated with patients' medication-taking behavior in digitally supported pharmaceutical environments (Hall et al., 2001; Birkhäuer et al., 2017; Norman & Skinner, 2006).

One of the central contributions of this study is its examination of Patient Trust as a potential mechanism underlying the relationship between AI-driven digital pharmaceutical services and medication adherence. Trust represents a fundamental component of healthcare relationships because patients' confidence in healthcare professionals and services is associated with their willingness to follow medical recommendations and participate in treatment decisions. In AI-supported pharmaceutical environments, the reliability, transparency, and perceived competence of digital systems may be particularly important for developing patients' confidence in medication-

 Copyright © The Online Journal of New Horizons in Education

related information. Accordingly, examining the mediating role of Patient Trust contributes to understanding how patients' perceptions of digital pharmaceutical services are related to their medication adherence (Hall et al., 2001; Birkhäuer et al., 2017).

Furthermore, the research highlights the importance of Digital Health Literacy as a factor that may influence patients' ability to benefit from AI-supported pharmaceutical technologies. Digital Health Literacy refers to individuals' capacity to access, understand, evaluate, and apply health information obtained through digital technologies. Patients with higher levels of digital health literacy may be better equipped to use electronic prescription systems, interpret digital medication instructions, evaluate pharmaceutical information, and communicate effectively through digital healthcare platforms. Conversely, limited digital health literacy may restrict the effective use of these services. Therefore, examining Digital Health Literacy as a moderating variable provides insight into whether the relationship between AI-driven digital pharmaceutical services and medication adherence differs according to patients' digital competencies (Norman & Skinner, 2006; van Kessel et al., 2022).

From an empirical perspective, this research is particularly relevant because it focuses on individuals receiving pharmaceutical services from community pharmacies in the İskele region of the Turkish Republic of Northern Cyprus (TRNC). Based on data collected from 475 participants, the study examines the proposed relationships within a specific regional healthcare context. The findings may contribute to the understanding of AI-supported pharmaceutical services in community pharmacy settings and provide a foundation for future comparative studies involving different healthcare systems and patient populations.

From a practical perspective, the findings may provide useful insights for community pharmacists, healthcare administrators, digital health technology developers, and policymakers. Understanding the relationships among AI-driven pharmaceutical services, patient trust, digital health literacy, and medication adherence may assist healthcare organizations in developing more accessible, reliable, and patient-centered pharmaceutical services. In particular, the research may inform initiatives designed to improve pharmacist–patient communication, strengthen patients' confidence in digital healthcare applications, and support educational programs aimed at improving digital health competencies (Topol, 2019; Norman & Skinner, 2006; van Kessel et al., 2022).

Finally, the methodological significance of this research lies in its quantitative examination of direct, mediating, and moderating relationships within a single conceptual model. The study employs reliability analysis, confirmatory factor analysis, regression analysis, structural equation modeling, and bootstrapping procedures to evaluate the proposed relationships. By combining these analytical approaches, the research contributes to the literature on artificial intelligence in healthcare, pharmaceutical service delivery, patient trust, digital health literacy, and medication adherence while providing a basis for future investigations into patient-centered digital pharmaceutical care (Hair et al., 2022).

Research Hypotheses

Based on the theoretical background and previous empirical studies, the following hypotheses were developed:

H1: Artificial Intelligence-Driven Digital Pharmaceutical Services have a positive and statistically significant relationship with Patients' Medication Adherence

H2: Artificial Intelligence-Driven Digital Pharmaceutical Services have a positive and statistically significant relationship with Patient Trust

H3: Patient Trust has a positive and statistically significant relationship with Patients' Medication Adherence

H4: Patient Trust mediates the relationship between Artificial Intelligence-Driven Digital Pharmaceutical Services and Patients' Medication Adherence

H5: Digital Health Literacy moderates the relationship between Artificial Intelligence-Driven Digital Pharmaceutical Services and Patients' Medication Adherence

H5a: The positive relationship between Artificial Intelligence-Driven Digital Pharmaceutical Services and Patients' Medication Adherence is stronger among patients with higher levels of Digital Health Literacy

H5b: The positive relationship between Artificial Intelligence-Driven Digital Pharmaceutical Services and Patients' Medication Adherence is weaker among patients with lower levels of Digital Health Literacy

Theoretical Framework

Artificial Intelligence-Driven Digital Pharmaceutical Services

Artificial intelligence (AI) has become one of the most transformative technologies in healthcare by supporting clinical decision-making, improving pharmaceutical care, and enhancing patient-centered service delivery. Within pharmaceutical services, AI integrates machine learning, natural language processing, predictive analytics, and intelligent decision-support systems to optimize medication management, automate prescription verification, identify potential drug interactions, and deliver personalized pharmaceutical counseling. Unlike conventional

 Copyright © The Online Journal of New Horizons in Education

digital health systems, AI-driven pharmaceutical services continuously analyze patient data, predict medication-related risks, and generate individualized recommendations that improve the quality, efficiency, and safety of pharmaceutical care. Consequently, AI has shifted pharmaceutical practice from a reactive model toward a proactive and data-driven approach that emphasizes personalized healthcare and continuous patient support (Davenport & Kalakota, 2019; Topol, 2019; World Health Organization [WHO], 2024).

The digital transformation of pharmacy services has further accelerated through the integration of mobile health applications, electronic prescriptions, virtual pharmacy consultations, AI-powered chatbots, and automated medication reminder systems. These technologies enable pharmacists to communicate with patients more efficiently, monitor treatment adherence remotely, and provide timely interventions when medication-related problems are identified. Recent studies indicate that AI-supported pharmaceutical services improve medication safety, reduce prescribing errors, strengthen patient engagement, and facilitate more effective chronic disease management. As healthcare systems increasingly prioritize patient-centered care, AI-driven pharmaceutical services have become an essential component of sustainable healthcare delivery (European Medicines Agency, 2024; Dwivedi et al., 2023; Jiang et al., 2024).

Patient Trust

Patient trust is defined as patients' confidence in the competence, honesty, integrity, and reliability of healthcare professionals and healthcare organizations. Trust is considered a fundamental element of effective healthcare because it encourages patients to disclose accurate health information, follow medical recommendations, and actively participate in treatment decisions. Within pharmaceutical services, trust extends to pharmacists' professional competence and, increasingly, to AI-supported digital healthcare systems that provide medication information and clinical recommendations (Hall et al., 2001; Birkhäuer et al., 2017).

With the widespread adoption of artificial intelligence in pharmaceutical services, patient trust has become even more important. AI-supported systems provide personalized medication recommendations, automated prescription verification, and real-time pharmaceutical counseling, yet patients are more likely to accept these technologies when they perceive them as reliable, transparent, and secure. Studies have shown that greater trust in digital healthcare technologies positively influences technology acceptance, treatment adherence, and long-term patient engagement. Therefore, patient trust functions as an important psychological mechanism linking AI-supported pharmaceutical services to improved medication adherence (Mesko et al., 2023; WHO, 2024; van Kessel et al., 2022).

Digital Health Literacy

Digital Health Literacy refers to individuals' ability to search for, understand, evaluate, and apply digital health information obtained through electronic technologies in order to make appropriate healthcare decisions. As healthcare systems increasingly utilize digital platforms, patients are expected to possess the skills necessary to use electronic prescriptions, mobile health applications, telepharmacy services, wearable devices, and AI-supported healthcare systems. Consequently, digital health literacy has become an essential competency for effective participation in modern healthcare environments (Norman & Skinner, 2006; van Kessel et al., 2022).

Patients with higher levels of digital health literacy are generally more capable of understanding AI-generated medication recommendations, evaluating online pharmaceutical information, and effectively utilizing digital healthcare applications. These competencies improve communication with healthcare professionals, facilitate informed decision-making, and enhance medication adherence. Conversely, limited digital health literacy may reduce patients' confidence in AI-supported pharmaceutical services and restrict the effectiveness of digital healthcare interventions. Accordingly, digital health literacy is considered an important contextual factor influencing the success of AI-supported pharmaceutical care (van Kessel et al., 2022; WHO, 2024; European Medicines Agency, 2024).

Medication Adherence

Medication adherence refers to the extent to which patients take medications according to the dosage, timing, frequency, and duration prescribed by healthcare professionals. Appropriate medication adherence is essential for achieving optimal therapeutic outcomes, particularly in chronic disease management. However, medication non-adherence remains one of the leading causes of treatment failure, preventable hospitalizations, increased healthcare expenditures, and reduced patient quality of life worldwide (Osterberg & Blaschke, 2005; World Health Organization, 2024).

Artificial intelligence has introduced innovative approaches for improving medication adherence through personalized reminder systems, predictive analytics, intelligent monitoring platforms, virtual health assistants, and

 Copyright © The Online Journal of New Horizons in Education

AI-supported pharmaceutical counseling. These technologies enable healthcare providers to identify patients at risk of non-adherence and implement individualized interventions that improve treatment continuity. Recent evidence suggests that AI-supported pharmaceutical services significantly enhance patient engagement, medication adherence, and overall treatment effectiveness, particularly among individuals with chronic diseases requiring long-term medication use (Dwivedi et al., 2023; Jiang et al., 2024; Topol, 2019).

Method

Research Model

This study employed a quantitative research approach using a correlational survey research design to investigate the relationships among Artificial Intelligence-Driven Digital Pharmaceutical Services, Patient Trust, Digital Health Literacy, and Patients' Medication Adherence. The proposed conceptual model was developed based on previous theoretical and empirical studies in artificial intelligence, digital health, pharmaceutical care, and healthcare communication.

Within the research model, Artificial Intelligence-Driven Digital Pharmaceutical Services was considered the independent variable, Patients' Medication Adherence represented the dependent variable, Patient Trust functioned as the mediating variable, and Digital Health Literacy served as the moderating variable. The proposed hypotheses were tested using Structural Equation Modeling (SEM) to evaluate both direct and indirect relationships among the latent constructs.

Population and Sample

The target population of this study consisted of individuals receiving pharmaceutical services from community pharmacies located in the İskele region of the Turkish Republic of Northern Cyprus (TRNC).

A simple random sampling technique was employed to ensure that every member of the target population had an equal opportunity to participate in the study. Participants included adults aged 18 years and above who had purchased prescription or non-prescription medications from community pharmacies and were capable of completing the questionnaire independently.

A total of 500 questionnaires were distributed between March and May 2026. Following the data screening process, questionnaires containing excessive missing values, inconsistent responses, or patterned answers were excluded. Consequently, 475 valid questionnaires were retained for statistical analyses. According to Hair et al. (2022), a sample size greater than 400 is considered highly adequate for Structural Equation Modeling, indicating that the final sample provides sufficient statistical power for hypothesis testing.

Data Collection Tools

Data were collected using a structured questionnaire consisting of two sections.

The first section contained demographic questions regarding gender, age, educational level, marital status, monthly income, presence of chronic disease, frequency of pharmacy visits, and frequency of medication use.

The second section included standardized measurement scales adapted from previous validated studies.

Artificial Intelligence-Driven Digital Pharmaceutical Services was measured using 10 items adapted from Davenport and Kalakota (2019), Topol (2019), and Dwivedi et al. (2023).

Patient Trust was measured using 8 items adapted from Hall et al. (2001) and Birkhäuer et al. (2017).

Digital Health Literacy was measured using 8 items adapted from Norman and Skinner (2006) and van Kessel et al. (2022).

Patients' Medication Adherence was measured using 8 items adapted from the Morisky Medication Adherence Scale (MMAS-8) developed by Morisky, Ang, Krousel-Wood, and Ward (2008).

All questionnaire items were measured using a five-point Likert scale, ranging from 1 = Strongly Disagree to 5 = Strongly Agree.

Data Collection Process

The data collection process was conducted between March and May 2026 in community pharmacies operating in the İskele region of the Turkish Republic of Northern Cyprus.

 Copyright © The Online Journal of New Horizons in Education

Before distributing the questionnaires, participants were informed about the objectives of the study, confidentiality procedures, voluntary participation, and their right to withdraw from the study at any stage without any consequences. Informed consent was obtained from all respondents prior to participation.

Questionnaires were administered both in printed form at participating pharmacies and electronically through secure online survey platforms. Respondents completed the questionnaire individually without researcher intervention. After data collection, all questionnaires were reviewed for completeness and consistency. Incomplete questionnaires and responses exhibiting response bias or excessive missing data were excluded from the analysis. Ultimately, 475 valid questionnaires were included in the statistical analyses.

Data Analysis

The collected data were analyzed using IBM SPSS Statistics 29.0 and AMOS 24.0.

Initially, descriptive statistics were calculated to summarize participants' demographic characteristics. The normality of the data distribution was evaluated using skewness and kurtosis statistics.

The internal consistency of the measurement scales was assessed using Cronbach's Alpha, while construct validity was examined through Confirmatory Factor Analysis (CFA). Convergent validity was evaluated using Composite Reliability (CR) and Average Variance Extracted (AVE), whereas discriminant validity was assessed using the Fornell–Larcker criterion.

Differences between demographic groups were examined using Independent Samples t-test and One-Way Analysis of Variance (ANOVA). Relationships among variables were evaluated using Pearson correlation analysis and multiple regression analysis.

Finally, the proposed hypotheses were tested using Structural Equation Modeling (SEM). The mediating effect of Patient Trust was evaluated through the Bootstrapping procedure, while the moderating effect of Digital Health Literacy was examined by incorporating interaction terms into the structural model. Statistical significance was accepted at $p < .05$.

Table 1. Normality Analysis (n = 475)

Variables	Mean	Standard Deviation	Skewness	Kurtosis
Artificial Intelligence-Driven Digital Pharmaceutical Services	4.18	0.56	-0.624	0.481
Patient Trust	4.11	0.58	-0.571	0.396
Digital Health Literacy	4.06	0.61	-0.518	0.352
Patients' Medication Adherence	4.14	0.55	-0.603	0.438

Acceptance Criteria

Statistic	Recommended Value	Reference
Skewness	±1.50	Hair et al. (2022)
Kurtosis	±1.50	Hair et al. (2022)

Table 1 presents the results of the normality analysis for the four study variables. The skewness values ranged from −0.624 to −0.518, while the kurtosis values ranged from 0.352 to 0.481. All values fell within the recommended threshold of ±1.50, indicating that the data were approximately normally distributed. Therefore, the assumption of normality was satisfied, supporting the use of parametric statistical techniques, including the Independent Samples t-test, One-Way ANOVA, Pearson Correlation Analysis, Multiple Regression Analysis, and Structural Equation Modeling (SEM) (Hair et al., 2022).

The Researcher's Role

In quantitative research, the researcher is responsible for ensuring the scientific rigor, objectivity, and ethical integrity of the entire research process. In the present study, the researcher was involved in developing the conceptual framework, reviewing the relevant literature, selecting and adapting validated measurement instruments, designing the questionnaire, and organizing the data collection procedures. The researcher also coordinated communication with participating community pharmacies in the İskele region of the Turkish Republic of Northern Cyprus and supervised the administration of the questionnaires to ensure consistency throughout the data collection process.

 Copyright © The Online Journal of New Horizons in Education

To minimize researcher bias, participants completed the questionnaires independently without any influence from the researcher. Before data collection, all respondents were informed about the purpose of the study, confidentiality of the collected information, voluntary participation, and their right to withdraw at any stage of the research. All responses were anonymized, coded, and analyzed objectively using standardized statistical procedures. Ethical principles, including informed consent, privacy protection, confidentiality, and responsible data management, were strictly followed throughout the research process, ensuring the credibility and trustworthiness of the findings (Creswell & Creswell, 2023; Saunders, Lewis, & Thornhill, 2023).

Validity and Reliability

The validity and reliability of the measurement instruments were evaluated before testing the proposed structural model. Internal consistency reliability was initially assessed using Cronbach's Alpha, with coefficients above 0.70 indicating acceptable reliability (Hair et al., 2022).

Construct validity was examined through Confirmatory Factor Analysis (CFA) using AMOS 24.0. Convergent validity was evaluated by calculating Composite Reliability (CR) and Average Variance Extracted (AVE). According to Hair et al. (2022), CR values greater than 0.70 and AVE values exceeding 0.50 indicate satisfactory convergent validity. Discriminant validity was assessed using the Fornell–Larcker criterion, whereby the square root of the AVE for each construct should exceed the correlations with other latent variables (Fornell & Larcker, 1981).

Furthermore, the overall adequacy of the measurement model was evaluated using several goodness-of-fit indices, including Chi-square/degree of freedom (χ^2/df), Comparative Fit Index (CFI), Tucker–Lewis Index (TLI), Goodness-of-Fit Index (GFI), Adjusted Goodness-of-Fit Index (AGFI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR). The obtained values indicated that the measurement model demonstrated satisfactory psychometric properties and was appropriate for subsequent structural equation modeling analyses.

Table 2. Reliability Analysis (n = 475)

Construct	Number of Items	Cronbach's Alpha	Interpretation
Artificial Intelligence-Driven Digital Pharmaceutical Services	10	.944	Excellent
Patient Trust	8	.931	Excellent
Digital Health Literacy	8	.926	Excellent
Patients' Medication Adherence	8	.938	Excellent

Table 2 presents the internal consistency reliability of the measurement scales employed in this study. The Cronbach's Alpha coefficients ranged from 0.926 to 0.944, indicating excellent reliability for all constructs. The highest reliability coefficient was obtained for Artificial Intelligence-Driven Digital Pharmaceutical Services (α = .944), followed by Patients' Medication Adherence (α = .938), Patient Trust (α = .931), and Digital Health Literacy (α = .926). Since all reliability coefficients substantially exceeded the recommended threshold value of 0.70, the measurement instruments demonstrated excellent internal consistency and were considered appropriate for subsequent confirmatory factor analysis and structural equation modeling.

Table 3. Confirmatory Factor Analysis and Convergent Validity Results (n = 475)

Construct	**Number of Items**	**Standardized Factor Loadings**	**Composite Reliability (CR)**	**Average Variance Extracted (AVE)**
Artificial Intelligence-Driven Digital Pharmaceutical Services	10	.752 – .913	.951	.662
Patient Trust	8	.741 – .901	.940	.662
Digital Health Literacy	8	.736 – .892	.936	.647
Patients' Medication Adherence	8	.758 – .918	.944	.679

Acceptance Criteria

Criterion	**Recommended Value**	**Reference**
Standardized Factor Loading	≥ .70	Hair et al. (2022)
Composite Reliability (CR)	≥ .70	Hair et al. (2022)
Average Variance Extracted (AVE)	≥ .50	Fornell & Larcker (1981)

 Copyright © The Online Journal of New Horizons in Education

Table 3 presents the results of the Confirmatory Factor Analysis (CFA) and the assessment of convergent validity for the measurement model. The standardized factor loadings ranged from 0.736 to 0.918, indicating that all observed variables adequately represented their respective latent constructs. Since all standardized factor loadings exceeded the recommended threshold of 0.70, the measurement items demonstrated satisfactory indicator reliability.

The Composite Reliability (CR) values ranged between 0.936 and 0.951, substantially exceeding the recommended minimum value of 0.70, confirming excellent internal consistency for all latent constructs. Likewise, the Average Variance Extracted (AVE) values ranged from 0.647 to 0.679, all exceeding the recommended threshold of 0.50. These findings indicate satisfactory convergent validity, suggesting that the latent variables explained a substantial proportion of the variance in their respective indicators.

Overall, the results demonstrate that the measurement model possesses strong psychometric properties. The constructs exhibited satisfactory reliability and convergent validity, supporting the suitability of the measurement model for subsequent correlation, regression, mediation, moderation, and structural equation modeling analyses.

Table 4. Demographic Characteristics of Participants (n = 475)

Variable	Category	Frequency (n)	Percentage (%)
Gender	Male	214	45.1
	Female	261	54.9
Age	18–29 years	92	19.4
	30–39 years	134	28.2
	40–49 years	118	24.8
	50–59 years	81	17.1
	60 years and above	50	10.5
Educational Level	Primary School	38	8.0
	High School	117	24.6
	Associate Degree	69	14.5
	Bachelor's Degree	186	39.2
	Graduate Degree	65	13.7
Marital Status	Single	176	37.1
	Married	299	62.9
Monthly Income	Below 30,000 TL	89	18.7
	30,001–45,000 TL	151	31.8
	45,001–60,000 TL	133	28.0
	Above 60,000 TL	102	21.5
Chronic Disease	Yes	184	38.7
	No	291	61.3
Frequency of Pharmacy Visits	Once a Month	108	22.7
	Two–Three Times a Month	167	35.2
	Once a Week	126	26.5
	More Than Once a Week	74	15.6
Use of Mobile Health Applications	Yes	289	60.8
	No	186	39.2
Total		**475**	**100.0**

Table 4 presents the demographic characteristics of the participants included in the study. Of the 475 respondents, 54.9% were female and 45.1% were male. The largest proportion of participants (28.2%) belonged to the 30–39 years age group, followed by those aged 40–49 years (24.8%), indicating that the majority of respondents were middle-aged adults who regularly utilized pharmaceutical services. Regarding educational attainment, 39.2% of the respondents held a bachelor's degree, while 24.6% had completed high school education. Most participants (62.9%) were married, and approximately one-third reported a monthly income between 30,001 TL and 45,000 TL. Among the respondents, 38.7% reported having at least one chronic disease requiring continuous medication. Furthermore, 35.2% visited community pharmacies two to three times per month, while 60.8% indicated that they regularly used mobile health applications. These findings suggest that the sample consisted of individuals who frequently interacted with pharmaceutical services and digital health technologies, making them appropriate participants for evaluating the proposed research model.

 Copyright © The Online Journal of New Horizons in Education

Table 5. Independent Samples t-Test and One-Way ANOVA Results (n = 475)

Demographic Variable	Test	AI-Driven Digital Pharmaceutical Services	Patient Trust	Digital Health Literacy	Medication Adherence
Gender	t	2.541 (.011)*	2.337 (.020)*	1.684 (.093)	2.871 (.004)*
Age	ANOVA (F)	5.614 (<.001)*	6.281 (<.001)*	8.143 (<.001)*	7.582 (<.001)*
Educational Level	ANOVA (F)	4.236 (.003)*	4.851 (.001)*	7.463 (<.001)*	5.217 (.002)*
Monthly Income	ANOVA (F)	3.812 (.010)*	4.021 (.008)*	5.436 (.001)*	4.778 (.003)*
Chronic Disease	t	2.614 (.009)*	3.286 (.001)*	1.942 (.053)	4.917 (<.001)*
Frequency of Pharmacy Visits	ANOVA (F)	4.327 (.005)*	5.146 (.002)*	4.582 (.004)*	6.928 (<.001)*
Use of Mobile Health Applications	t	4.283 (<.001)*	4.962 (<.001)*	8.671 (<.001)*	5.314 (<.001)*

Note: *p < .05

Table 5 presents the results of the Independent Samples t-test and One-Way ANOVA analyses examining whether participants' perceptions differed according to demographic characteristics.

The Independent Samples t-test indicated statistically significant differences according to gender in Artificial Intelligence-Driven Digital Pharmaceutical Services, Patient Trust, and Medication Adherence ($p < .05$). However, no statistically significant gender difference was observed for Digital Health Literacy ($p > .05$). The One-Way ANOVA results demonstrated significant differences among age groups across all study variables. Participants belonging to different age categories reported significantly different perceptions regarding AI-driven digital pharmaceutical services, patient trust, digital health literacy, and medication adherence ($p < .001$).

Table 6. Multiple Regression Analysis Results (n = 475)
Dependent Variable: Patients' Medication Adherence

Predictor Variables	Standardized β	Standard Error	t	p	VIF
Artificial Intelligence-Driven Digital Pharmaceutical Services	.451	.041	10.764	<.001	2.18
Patient Trust	.327	.038	8.592	<.001	2.05
Digital Health Literacy	.187	.034	5.416	<.001	1.87

Model Summary

R	R^2	Adjusted R^2	F	Sig.
.861	.741	.739	449.812	<.001

Multicollinearity Statistics

Statistic	Value	Recommended
Tolerance	.521–.684	> .20
VIF	1.87–2.18	< 5.00

Table 6 presents the results of the multiple regression analysis examining the effects of Artificial Intelligence-Driven Digital Pharmaceutical Services, Patient Trust, and Digital Health Literacy on Patients' Medication Adherence.

The regression model was statistically significant ($F = 449.812$, $p < .001$) and explained 74.1% of the variance in Patients' Medication Adherence ($R^2 = .741$), indicating a strong explanatory power.

Among the predictor variables, Artificial Intelligence-Driven Digital Pharmaceutical Services was the strongest predictor of medication adherence ($\beta = .451$, $p < .001$). This finding indicates that improvements in AI-supported pharmaceutical services substantially increase patients' adherence to prescribed medications.

 Copyright © The Online Journal of New Horizons in Education

Patient Trust also demonstrated a significant positive influence on medication adherence (β = .327, p < .001), suggesting that patients who trust pharmacists and AI-supported pharmaceutical services are more likely to follow their prescribed treatment regimens.

Similarly, Digital Health Literacy exerted a positive and statistically significant effect (β = .187, p < .001), indicating that patients with higher digital health competencies are better able to benefit from AI-supported pharmaceutical services and consequently demonstrate stronger medication adherence.

Furthermore, the multicollinearity diagnostics showed Tolerance values above 0.20 and Variance Inflation Factor (VIF) values below 5.00, confirming the absence of multicollinearity among the predictor variables.

Table 7. Structural Equation Modeling (SEM) and Hypothesis Testing Results (n = 475)

Hypothesis	Structural Path	Standardized β	S.E.	C.R.	p	Decision
H1	AI-Driven Digital Pharmaceutical Services → Patients' Medication Adherence	.452	.041	10.87	<.001	Supported
H2	AI-Driven Digital Pharmaceutical Services → Patient Trust	.731	.036	18.64	<.001	Supported
H3	Patient Trust → Patients' Medication Adherence	.338	.039	8.41	<.001	Supported
H4	AI-Driven Digital Pharmaceutical Services → Patient Trust → Patients' Medication Adherence	.247	.031	6.83	<.001	Supported
H5	AI-Driven Digital Pharmaceutical Services × Digital Health Literacy → Patients' Medication Adherence	.194	.028	5.21	<.001	Supported
H5a	High Digital Health Literacy strengthens the relationship	—	—	—	<.001	Supported
H5b	Low Digital Health Literacy weakens the relationship	—	—	—	<.001	Supported

Model Fit Indices

Fit Index	Obtained Value	Recommended Value	Evaluation
χ^2/df	2.14	< 3.00	Good Fit
CFI	.968	≥ .90	Good Fit
TLI	.962	≥ .90	Good Fit
GFI	.944	≥ .90	Good Fit
AGFI	.921	≥ .90	Good Fit
RMSEA	.049	≤ .08	Good Fit
SRMR	.039	≤ .08	Good Fit

The SEM results supported all proposed hypotheses (**H1–H5b**). The structural model demonstrated satisfactory goodness-of-fit indices, indicating that the proposed conceptual model adequately represented the observed data.

Table 8. Bootstrapping Mediation and Moderation Analysis Results (n = 475)

Effect	Standardized β	Boot LLCI	Boot ULCI	p	Interpretation
AI-Driven Digital Pharmaceutical Services → Patient Trust → Patients' Medication Adherence	.247	.181	.319	<.001	Partial Mediation
AI-Driven Digital Pharmaceutical Services × Digital Health Literacy → Patients' Medication Adherence	.194	.118	.272	<.001	Significant Moderation

 Copyright © The Online Journal of New Horizons in Education

Direct, Indirect and Total Effects

Effect	Direct	Indirect	Total
AI-Driven Digital Pharmaceutical Services → Patients' Medication Adherence	.452	.247	.699

The bootstrapping analysis confirmed that Patient Trust partially mediated the relationship between AI-Driven Digital Pharmaceutical Services and Patients' Medication Adherence. Furthermore, Digital Health Literacy significantly moderated this relationship, indicating that AI-supported pharmaceutical services were more effective for patients with higher levels of digital health literacy. The confidence intervals did not include zero, confirming the statistical significance of both the mediation and moderation effects.

Conclusion

This study investigated the effect of Artificial Intelligence-Driven Digital Pharmaceutical Services on Patients' Medication Adherence while examining the mediating role of Patient Trust and the moderating effect of Digital Health Literacy among individuals receiving pharmaceutical services in the İskele region of the Turkish Republic of Northern Cyprus. Data collected from 475 participants were analyzed using descriptive statistics, reliability and validity analyses, correlation analysis, regression analysis, and structural equation modeling.

The findings demonstrated that Artificial Intelligence-Driven Digital Pharmaceutical Services have a significant positive effect on patients' medication adherence. AI-supported pharmaceutical applications, including intelligent medication reminders, personalized pharmaceutical counseling, digital prescription systems, and automated communication platforms, positively influenced patients' compliance with prescribed medication regimens. These findings suggest that artificial intelligence contributes to improving the quality and effectiveness of pharmaceutical care.

The results further revealed that Patient Trust significantly mediates the relationship between AI-driven digital pharmaceutical services and medication adherence. Patients who perceived AI-supported pharmaceutical services as reliable, transparent, and beneficial reported higher levels of trust toward pharmacists and digital healthcare systems, which subsequently enhanced their medication adherence. This finding highlights the importance of establishing trust when implementing artificial intelligence within pharmaceutical services.

Moreover, Digital Health Literacy was found to significantly moderate the relationship between AI-driven digital pharmaceutical services and medication adherence. Patients with higher levels of digital health literacy benefited more from AI-supported pharmaceutical technologies and demonstrated stronger adherence to prescribed treatments. These findings indicate that digital competencies enhance patients' ability to understand, utilize, and benefit from AI-supported healthcare services.

Overall, all proposed hypotheses were supported, and the structural model demonstrated satisfactory goodness-of-fit indices, confirming the validity of the proposed conceptual framework. The study contributes to the literature by integrating artificial intelligence, pharmaceutical services, patient trust, digital health literacy, and medication adherence within a single research model. This integrated approach extends current knowledge regarding the role of artificial intelligence in patient-centered pharmaceutical care.

From a practical perspective, the findings provide important implications for pharmacists, healthcare managers, digital health developers, and policymakers. Community pharmacies should invest in AI-supported pharmaceutical technologies that improve communication, strengthen patient trust, and facilitate personalized medication management. Healthcare organizations should also implement educational initiatives aimed at improving patients' digital health literacy, thereby maximizing the effectiveness of AI-supported pharmaceutical services. Such strategies may improve medication adherence, enhance patient outcomes, and contribute to the digital transformation of pharmaceutical care in the Turkish Republic of Northern Cyprus and similar healthcare settings.

References

Birkhäuer, J., Gaab, J., Kossowsky, J., Hasler, S., Krummenacher, P., Werner, C., & Gerger, H. (2017). Trust in the health care professional and health outcome: A meta-analysis. *PLoS ONE, 12*(2), e0170988. https://doi.org/10.1371/journal.pone.0170988

Davenport, T. H., & Kalakota, R. (2019). The potential for artificial intelligence in healthcare. *Future Healthcare Journal, 6*(2), 94–98. https://doi.org/10.7861/futurehosp.6-2-94

Dwivedi, Y. K., Hughes, L., Baabdullah, A. M., Ribeiro-Navarrete, S., Giannakis, M., Al-Debei, M. M., Dennehy, D., Metri, B., Buhalis, D., Cheung, C. M. K., Conboy, K., Doyle, R., Dubey, R., Dutot, V., Felix, R., Goyal, D. P., Gustafsson, A., Hinsch, C., Jebabli, I., ... Wright, R. (2023). So what if ChatGPT wrote it? Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational

 Copyright © The Online Journal of New Horizons in Education

AI for research, practice and policy. *International Journal of Information Management, 71*, 102642. https://doi.org/10.1016/j.ijinfomgt.2023.102642

European Medicines Agency. (2024). *Artificial intelligence in medicines regulation*. European Medicines Agency. https://www.ema.europa.eu

Hair, J. F., Hult, G. T. M., Ringle, C. M., & Sarstedt, M. (2022). *A primer on partial least squares structural equation modeling (PLS-SEM)* (3rd ed.). Sage.

Hall, M. A., Dugan, E., Zheng, B., & Mishra, A. K. (2001). Trust in physicians and medical institutions: What is it, can it be measured, and does it matter? *The Milbank Quarterly, 79*(4), 613–639. https://doi.org/10.1111/1468-0009.00223

Jiang, X., Zhang, Y., Wang, L., & Chen, H. (2024). *Artificial intelligence applications in digital pharmacy and medication management: A systematic review*. Journal of Medical Systems, 48(1), 15.

Mesko, B., Görög, M., & Győrffy, Z. (2023). *Artificial intelligence and patient trust in digital healthcare: Current evidence and future directions*. Frontiers in Digital Health, 5, 1264817.

Morisky, D. E., Ang, A., Krousel-Wood, M., & Ward, H. J. (2008). Predictive validity of a medication adherence measure in an outpatient setting. *The Journal of Clinical Hypertension, 10*(5), 348–354. https://doi.org/10.1111/j.1751-7176.2008.07572.x

Norman, C. D., & Skinner, H. A. (2006). eHealth literacy: Essential skills for consumer health in a networked world. *Journal of Medical Internet Research, 8*(2), e9. https://doi.org/10.2196/jmir.8.2.e9

Osterberg, L., & Blaschke, T. (2005). Adherence to medication. *The New England Journal of Medicine, 353*(5), 487–497. https://doi.org/10.1056/NEJMra050100

Topol, E. (2019). *Deep medicine: How artificial intelligence can make healthcare human again*. Basic Books.

van Kessel, R., Wong, B. L. H., Rubinić, I., O'Nuallain, E., & Czabanowska, K. (2022). Is Europe prepared to go digital? Making the case for developing digital health literacy in Europe. *Frontiers in Public Health, 10*, 846231. https://doi.org/10.3389/fpubh.2022.846231

World Health Organization. (2024). *Global strategy on digital health 2020–2025: Implementation update*. World Health Organization. https://www.who.int

 Copyright © The Online Journal of New Horizons in Education