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Article

Public perspectives on digital innovations in pharmacy: A survey on health informatics and medication management

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Abstract: This study investigates the public's perceptions of digital innovations in pharmacy, with a focus on health informatics and medication management. Despite the rapid development of these technologies, a comprehensive understanding of how various demographics perceive and interact with them is lacking hence, this research aims to bridge this gap by offering insights into public attitudes and the factors influencing the adoption of digital tools in pharmacy practice, as KSA population and healthcare professionals after Covid-19 has observed the significant potential of digital health. A cross-sectional survey involving 1132 participants was conducted, employing SPSS for data analysis to ensure precise and reliable results. The findings indicate general optimism about the potential of digital innovations to enhance healthcare outcomes but concerns about data privacy and usability significantly affect user acceptance. The researchers recommended tailored educational programs and user-centered design to facilitate the adoption of digital pharmacy innovations. Key contributions include the identification of 'Ease of Use' and 'Data Security and Privacy' as predominant factors in the adoption of digital health tools.

Keywords: digital pharmacy innovations; public perceptions; health informatics; medication management; digital health adoption; data privacy; user-centered design; cluster analysis

1. Introduction

The field of pharmacy is undergoing a significant transformation due to the rapid adoption of digital innovations and health informatics technologies. These advancements are revolutionizing medication management protocols, enhancing patient outcomes, and increasing the overall efficiency of healthcare delivery. Given the growing integration of these technologies within the pharmacy ecosystem, it is crucial to understand public perceptions and attitudes toward these changes. This study aims to explore the public's perspectives on digital innovations in pharmacy, with a focus on health informatics and medication management strategies, to identify factors that influence their acceptance and use.

2. Literature review

2.1. Digital innovations in pharmacy

The integration of digital technologies in pharmacy practices is revolutionizing the field by enhancing the safety and efficiency of medication management. Electronic Health Records (EHRs) and digital prescription systems have become fundamental in improving the interaction between healthcare providers and patients, ensuring more precise medication management and secure data handling (Alhur et al., 2023; Jarab et al., 2023). These advancements contribute to streamlining healthcare operations and enhancing patient outcomes. Moreover, digital tools facilitate real-time monitoring and patient data analysis, which are essential for personalized medicine (Deslich et al., 2013; Trenfield et al., 2022). Continuous innovation and evaluation are crucial to keeping pace with rapid technological advances and ensuring these tools meet the ever-evolving healthcare needs (Alhur, 2023; Bennadi, 2014; Gaylin et al., 2011).

2.2. Public perceptions of healthcare technologies

The successful integration of digital healthcare technologies into everyday clinical practice is heavily influenced by public perceptions. These perceptions are shaped by various factors, including the usability of the technology, accessibility of the systems, and concerns regarding the security of personal data (Ahmed et al., 2018; Campos-Castillo and Anthony, 2019). Furthermore, the complexity of navigating these digital systems often poses a significant barrier to their adoption (Dhagarra et al., 2020; Goode et al., 2019). Positive user experiences, enhanced by user-friendly interfaces and robust privacy protections, are critical in garnering wide acceptance (Beets et al., 2023; Narynov et al., 2021). Educational campaigns and transparent communication about the benefits and protections offered by these technologies can further enhance public trust and acceptance (Hutchings et al., 2020; Sharma et al., 2020; Zapata et al., 2015).

2.3. Trust and privacy concerns

Trust and privacy are critical in the digital healthcare sector. The effectiveness of healthcare innovations is significantly influenced by their ability to protect sensitive patient information and maintain high standards of confidentiality (Alhur et al., 2024; François et al., 2024). Ensuring these technologies are equipped with advanced security features and clear, comprehensive privacy policies is essential for building trust among end-users (Powell and Torous, 2020; Pérez-Jover et al., 2019). Moreover, regular audits and updates to security protocols are necessary to address emerging threats and vulnerabilities, thereby reinforcing user confidence in these digital solutions (Bennadi, 2014; Gaylin et al., 2011; Zapata et al., 2015).

2.4. Medication adherence Apps

Medication adherence apps represent a significant advancement in digital pharmacy innovations, designed to enhance patient engagement and improve adherence to prescribed medical regimens. These apps must be intuitive, secure, and adaptable to accommodate the varied needs of the patient population (Dayer et al., 2013; Sharma et al., 2020). They should also provide actionable insights into patient behavior and medication patterns to healthcare providers, enabling more effective patient management (Palumbo et al., 2021; Pérez-Jover et al., 2019). Continuous

technological refinement and rigorous effectiveness assessments are required to ensure these tools remain reliable and beneficial in promoting better health outcomes (Figueroa et al., 2022; Morgan, 2016; Narynov et al., 2021).

3. Methodology

This research employed a robust methodological approach to investigate the digital divide in pharmacy practices. The study was underpinned by a comprehensive survey developed through the collaboration of experts from the University of Hail. These experts, renowned for their work in health informatics and digital pharmacy innovations, utilized a blend of theoretical frameworks and empirical studies to construct a survey instrument that was both comprehensive and attuned to the complexities of digital innovations in pharmacy.

3.1. Questionnaire design

The questionnaire was designed by a panel of experts at the University of Hail in the fields of health informatics and pharmacy. The design process was informed by a thorough literature review to ensure the survey captured essential aspects of public perceptions regarding digital tools in pharmacy. This methodical approach facilitated the inclusion of a broad range of questions, carefully crafted to gauge participants' awareness, understanding, and perceptions of digital tools. A pilot test was conducted with a smaller subset of the target population to validate the questionnaire's reliability, which was confirmed by a Cronbach's alpha score indicating high internal consistency.

3.2. Data collection and statistical analysis

The data collection employed a cross-sectional survey, which was distributed over a period from 14/1/2024 to 7/3/2024 across various digital platforms to ensure extensive reach. The participants were selected using a stratified sampling method, aiming for a representative sample that encompassed diverse age groups, genders, and regional backgrounds. The sample size was determined through a power analysis, designed to detect a minimum effect size with 80% power at a 0.05 significance level. The responses were collected and processed using SPSS software 26, with the analysis incorporating both descriptive statistics to outline major trends and chi-square tests to examine deeper relationships within the data.

3.3. Ethical Considerations

The study adhered to strict ethical standards, obtaining formal approval from the University of Hail's Research Ethics Committee (reference number H-2024-016). Informed consent was systematically secured from all participants through a user-friendly online system that thoroughly informed them about the study's objectives, their role, and their rights, including the guarantee of anonymity and confidentiality. The University of Hail's Research Ethics Committee's endorsement of this study is a testament to its ethical integrity. Throughout the research process, rigorous measures were implemented to maintain the anonymity and confidentiality of the data, ensuring the utmost protection of participants' privacy and rights.

4. Results

This section presents the findings from the study, focusing on demographics, awareness, understanding, perceptions, and factors influencing the adoption of digital innovations in pharmacy.

4.1. Demographics

The study's participants were predominantly female, with 839 females (74.12%) and 293 males (25.88%). Younger individuals, especially those aged 18–24, formed the largest age group, with 651 participants, accounting for 57.51% of the total (**Table 1**).

Table 1. Demographics information.

Category	Frequency	Percentage (%)
Gender		
Female	839	74.12
Male	293	25.88
Age Group		
18–24 years	651	57.51
25–34 years	184	16.25
35–44 years	149	13.16
45–54 years	82	7.24
55–64 years	48	4.24
65 and older	18	1.59

4.2. Awareness and understanding

The average awareness of digital innovations in pharmacy among participants was 54.15%, with a standard deviation of 8.2%, indicating variability in awareness levels. The average understanding level was measured at 2.61 on a scale of 1 to 5, with a standard deviation of 0.75.

Table 2 presents the awareness and understanding levels among participants, reflecting moderate familiarity with digital innovations.

Table 2. Levels of awareness and understanding.

Awareness (%)	Understanding Level (Avg)
54.15	2.61

4.3. Perceptions and trust in digital innovations

The study recorded participants' perceptions and trust in digital innovations. The average agreement level for digital innovations improving healthcare outcomes was high at 4.33 (±0.89). Similarly, the average agreement for enhancing patient-provider communication was 4.31 (±0.85). However, concerns about data privacy were evident with a lower average agreement level of 3.27 (±1.10).

Table 3 illustrates participants' perceptions and trust levels concerning digital innovations, indicating strong belief in their benefits juxtaposed with privacy concerns.

Table 3. Participant perceptions and trust in digital innovations.

Statement	Agreement Level (Avg)
Digital innovations can improve healthcare outcomes	4.33
Digital innovations can enhance patient-provider communication	4.31
Concerns about the privacy of health information in digital systems	3.27

4.4. Factors influencing adoption

'Ease of Use' and 'Data Security and Privacy' were identified as the primary factors influencing the decision to adopt digital health tools, with 45% (±5%) of participants citing 'Ease of Use' as crucial.

Figure 1 illustrates that 'Ease of Use' (45%) and 'Data Security and Privacy' (25%) are predominant in influencing the adoption of digital health tools.

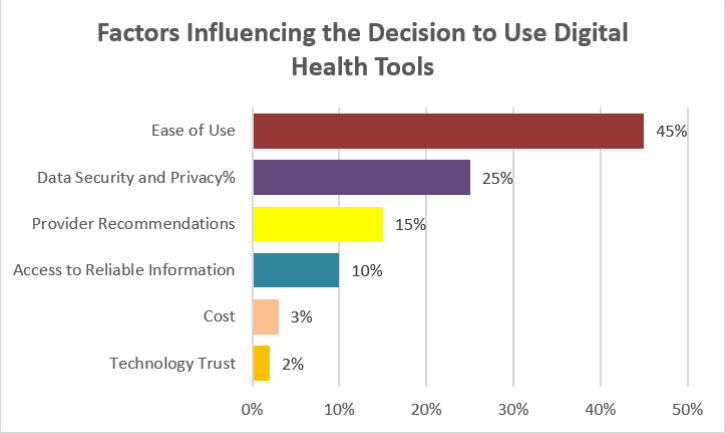

Figure 1. Influential factors for adopting digital health tools.

4.5. Regression analysis

The regression analysis (**Table 4**) showed that trust in digital innovations (coefficient: 0.1147, $p < 0.001$) and positive perceptions regarding their capabilities (coefficient: 0.1084, $p < 0.001$) significantly influenced tool adoption. In contrast, a higher level of awareness negatively correlated with willingness to use these tools (coefficient: –0.1039, $p = 0.005$).

Table 4. Regression analysis—coefficients and significance.

Predictor	Coefficient	*p*-value	Significance
Awareness	–0.1039	0.005	Yes
Understanding Level	0.0448	0.024	Yes
Trust in Digital Innovations	0.1147	< 0.001	Yes
Perceived Benefit: Healthcare Outcomes Improvement	0.0529	0.044	Yes
Perceived Benefit: Enhanced Patient-Provider Communication	0.1084	< 0.001	Yes
Concerns about Privacy	–0.0252	0.09	No

4.6. Cluster analysis

The cluster analysis (**Table 5**) categorized respondents into four groups based on

their attitudes toward digital pharmacy innovations, with 283 participants in Clusters 1 and 4, 340 in Cluster 2, and 226 in Cluster 3.

Table 5. Overview of cluster analysis findings.

Cluster	Avg Awareness	Avg Understanding	Avg Trust	Avg Willingness	Avg Perception Score	Avg Privacy Concern	Number of Respondents
(1)	High	High	High	High	Very Positive	Low	283
(2)	Moderate	Moderate	Moderate	Moderate	Positive	Moderate	340
(3)	Low	Low	Low	Low	Neutral	High	226
(4)	High	Low	Moderate	Moderate	Mixed	High	283

5. Discussion

The results of this study illuminate the broad spectrum of public attitudes towards and engagements with digital innovations in the pharmacy domain. The documented moderate levels of awareness and understanding among study participants suggest a significant opportunity for educational initiatives aimed at demystifying and promoting the advantages of digital health technologies. This observation is in line with the perspective that, despite the proliferation of digital health resources, there is a substantial gap in the public's digital health literacy, highlighting the necessity for dedicated efforts to distribute relevant information (Palumbo et al., 2021). Furthermore, a series of recent studies conducted in KSA have revealed a general lack of awareness about various healthcare technologies among the populace, indicating a consistent pattern of limited digital health literacy (Alhur, 2022; Alhur and Aldosari, 2024; Morgan, 2016).

The overall positive response to digital innovations, marked by participants recognizing their potential benefits, aligns with findings that underscore the favorable view healthcare consumers hold towards digital tools. This consensus supports the notion that while digital solutions are welcomed for their advantages, the prevalent apprehensions regarding data privacy echo larger reservations concerning digital health technologies. These concerns highlight a crucial area for policy revision and technological improvement, indicating the need for enhanced safeguards and transparency in the digital health realm (Dhagarra et al., 2020; François et al., 2024; Powell and Torous, 2020). Additionally, the widespread concerns about data privacy reflect broader misgivings related to digital health technologies, pinpointing a vital sector for policy reform and technological refinement (Ahmed et al., 2018).

The emphasis on usability and the security of data as crucial elements influencing the acceptance of digital tools reflects the principles of the Technology Acceptance Model, which asserts that the perceived ease of use and usefulness are fundamental in technology adoption. This indicates that making improvements in the user interface and strengthening data protection measures could have a significant effect on the adoption rates of digital pharmacy instruments, highlighting a direct route for boosting user engagement and confidence in these digital resources (Dayer et al., 2013).

Furthermore, the cluster analysis has delineated a range of perspectives on digital innovations in pharmacy, spanning from avid supporters to wary skeptics. Developing communication and engagement tactics that cater to the specific doubts and

information requirements of each identified group may significantly foster broader and more effective engagement with these digital solutions (François et al., 2024).

5.1. Study limitations and contributions

The study's results are influenced by the youthful skew of the participant base, potentially affecting the generalizability to older populations. The conventional steps of univariate analysis followed by multivariate analysis were adapted in our regression approach to suit the study's specific questions and hypotheses. The comprehensive approach and detailed analysis contribute to understanding the multifaceted attitudes toward digital health innovations and guide future strategies for broader and more inclusive adoption.

5.2. Implications and future directions

This research clarifies complex public views on digital improvements in pharmacy services, offering important insights for healthcare workers and policymakers. It highlights the need for actions that not only increase public knowledge and understanding of digital changes in pharmacies but also address concerns about privacy and security, thus creating a welcoming environment for their adoption.

Ongoing studies are essential to keep track of these views as digital health innovations develop and as policy frameworks change, influencing how the public sees and interacts with digital pharmacy innovations. Future research that follows these trends over time could deepen our understanding of how technology acceptance and usage in healthcare evolve.

6. Conclusion

This study has demonstrated the varied perspectives on digital innovations in pharmacy, highlighting a spectrum from enthusiastic proponents to cautious skeptics. The moderate awareness and understanding of these innovations suggest a significant opportunity for educational initiatives aimed at enhancing digital health literacy. Addressing privacy concerns and emphasizing the ease of use and perceived benefits of digital tools are pivotal to overcoming barriers to adoption. The positive perceptions towards the potential of digital innovations to improve healthcare outcomes and facilitate patient-provider communication underscore the readiness of the public to embrace these technologies, provided their concerns are adequately addressed.

Looking ahead, the dynamic nature of digital health innovations necessitates ongoing research to track shifts in public perceptions and adoption trends. Future studies should explore the effectiveness of targeted communication strategies tailored to the distinct segments identified in the cluster analysis, aiming to optimize the adoption and utilization of digital health tools. As digital innovations continue to evolve, a collaborative effort among healthcare practitioners, policymakers, and technology developers is essential to ensure that these tools meet the evolving needs and expectations of the public, ultimately enhancing healthcare delivery and patient outcomes.

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