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RESEARCH ARTICLE

# Digital pharmacology and medication adherence in Saudi Arabia

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## Abstract

**Background:** The study investigates the impact of digital pharmacology on medication adherence among the Saudi Arabian population. Digital health technologies, including e-prescriptions and mobile health applications, offer potential benefits for improving medication management and adherence. **Methods:** Utilizing a cross-sectional quantitative approach, the research gathered data through an online questionnaire distributed to a diverse sample of 1000 participants. The questionnaire designed by experts and validated through a pilot test, included sections on demographic information, use of digital health technologies, medication adherence, and perceptions of digital health tools. **Results:** The findings reveal a significant adoption of e-prescriptions, with mixed engagement in mobile health applications. While the majority of respondents exhibited high medication adherence, forgetfulness, complexity of medication regimens, and side effects were identified as key barriers. Positive perceptions towards digital health technologies were prevalent, indicating a strong interest in further information and adoption. **Conclusion:** The study underscores the necessity for targeted educational initiatives, simplified medication regimens, and robust digital health strategies to enhance healthcare delivery in Saudi Arabia. Ethical considerations were rigorously maintained, with approval from the Hail Cluster Ethical Committee.

**Keywords:** Digital pharmacology, Medication adherence, E-prescriptions, Mobile health applications, Saudi Arabia, Digital health technologies, Healthcare delivery, Cross-sectional study, Health informatics, Patient engagement

## Introduction

### Overview of digital pharmacology

Digital pharmacology represents the integration of digital technologies within the field of pharmacology to enhance medication management, improve patient adherence, and deliver more personalized healthcare solutions. This approach encompasses tools such as e-prescriptions, mobile health applications, telemedicine, and other innovations that streamline the monitoring and administration of medications. The introduction of digital pharmacology has shown significant potential in addressing traditional pharmacological challenges, including medication errors, patient non-adherence, and the inefficiencies in communication between healthcare providers and patients (Ventola, 2014).

### E-Prescriptions

E-prescriptions, or electronic prescriptions, enable healthcare providers to transmit prescriptions directly to pharmacies through electronic systems, minimizing the risks associated with handwritten prescriptions. Research has consistently shown that e-prescriptions can significantly enhance medication adherence by offering clear instructions, reducing patient wait times at pharmacies, and simplifying prescription renewals (Hsu et al., 2014). In Saudi Arabia, the adoption of e-prescriptions has been steadily increasing, driven by government initiatives aimed at modernizing healthcare services and integrating digital solutions into everyday medical practices (Alsulame et al., 2019). This aligns with broader goals outlined in Vision 2030 to digitize the healthcare sector and improve service delivery (Alhur, 2024).

### Mobile health applications

Mobile health applications, often referred to as mHealth apps, are another fundamental component of digital pharmacology. These applications are designed to assist users with medication reminders, track health metrics, and provide valuable educational resources. Evidence indicates that mHealth apps can play a critical role in boosting medication adherence by delivering timely reminders and ensuring that patients have easy access to relevant medication information (Boulos et al., 2011). However, the uptake of these apps in Saudi Arabia has been relatively slow compared to other digital tools, mainly due to ongoing concerns about data privacy and the reliability of app-based information (Bawazir et al., 2020).

### Telemedicine

Telemedicine leverages telecommunication technologies to deliver clinical healthcare services remotely, proving to be especially effective in reaching patients in remote or underserved areas. This digital approach not only enhances access to healthcare but also supports continuous patient monitoring and follow-up consultations, which are crucial for managing chronic conditions and ensuring adherence to prescribed treatments (Wootton, 2012). The expansion of telemedicine in Saudi Arabia was significantly accelerated by the COVID-19 pandemic, highlighting its importance in transforming healthcare delivery and its capacity to support medication adherence on a broader scale (Albahri et al., 2020).

### Previous research findings

The role of digital pharmacology in enhancing patient outcomes has been well-documented in various studies. For example, research findings have demonstrated that e-prescriptions are linked with higher medication adherence rates and a notable reduction in medication errors in Saudi Arabia (Alshahrani et al., 2019). Similarly, mobile health applications have been shown to improve patient engagement and compliance with treatment regimens, reinforcing the role of technology in patient-centered care (Boulos et al., 2011). Nevertheless, studies have also underscored significant barriers to the widespread adoption of these technologies, such as data privacy concerns, varying levels of digital literacy, and the need for robust regulatory frameworks to ensure the efficacy and safety of these tools (Bawazir et al., 2020).

### Challenges and barriers

Despite its potential, digital pharmacology faces several challenges that must be addressed to optimize its impact. Concerns regarding data privacy, especially with mobile health applications that handle sensitive health information,

remain a primary obstacle. Building trust in these technologies requires strict adherence to data protection standards and clear communication about data security measures to reassure users (Bawazir et al., 2020). Additionally, the digital divide continues to be a significant issue, as not all individuals have equal access to technology or possess the necessary digital literacy to utilize these tools effectively (van Dijk, 2020).

Interoperability between various digital health systems also poses a challenge. To maximize the effectiveness of digital pharmacology, seamless integration and communication across different platforms and healthcare providers are essential. Achieving this level of interoperability requires standardized protocols and a collaborative approach among stakeholders in the healthcare sector (Kuhn et al., 2016).

### Research gap and rationale

While existing literature has investigated the effectiveness of digital health technologies across various healthcare settings, there remains a lack of focused research on their specific impact on medication adherence among the Saudi Arabian population. This study aims to fill this gap by exploring the role of digital pharmacology in enhancing medication adherence in Saudi Arabia. By examining a specific demographic within a unique healthcare context, the research seeks to generate insights that will guide the development of more targeted and effective digital health interventions in the region (Alhur, 2024).

## Methodology

### Research design

The study employed a cross-sectional quantitative design to assess the effects of digital pharmacology on medication adherence in Saudi Arabia. This approach was chosen because it provides a snapshot of current trends and preferences within a specified timeframe. The cross-sectional design is particularly suitable for identifying associations between variables, such as the use of digital health technologies and medication adherence, across a diverse population.

### Sampling technique

To ensure that the sample was representative, a random sampling technique was utilized. This method was chosen to minimize selection bias and ensure that the sample accurately reflects the larger population. The inclusion criteria required participants to be residents of Saudi Arabia and at least 18 years old. Individuals younger than 18 years were excluded to focus on adults who are more likely to be responsible for their medication management and use of digital health technologies.

The sample size was determined based on the population size of Saudi Arabia, aiming for a confidence level of 95% and a margin of error of 5%. This calculation suggested a minimum sample size of approximately 385 participants, but the study targeted recruiting at least 1,000 individuals to increase the robustness of the findings and allow for more detailed subgroup analyses.

### Instrumentation and data collection

A structured questionnaire was developed by a team of experts from the College of Pharmacy and Public Health and Health Informatics. The questionnaire was designed to comprehensively capture data relevant to the study's objectives and consisted of five sections:

**Demographic information:** Included items on gender, age, education level, occupation, and other relevant demographic details.

**Use of digital health technologies:** Focused on usage patterns of e-prescriptions, mobile health applications, and other digital health tools.

**Medication adherence:** Assessed the frequency of medication adherence, reasons for non-adherence, and strategies used for adherence.

**Perception and challenges:** Evaluated the respondents' perceptions of the usefulness of digital health technologies and the challenges faced in their adoption.

**Additional information:** Collected any other relevant feedback or information from the respondents.

The questionnaire was validated through a pilot test involving a small group of participants to ensure clarity, relevance, and reliability. Adjustments were made based on feedback to refine the questions. Data collection was conducted using an online questionnaire hosted on Google Forms, chosen for its accessibility and ease of use. The questionnaire was translated into Arabic to ensure comprehensibility, with a back-translation process used to verify the accuracy of the translation.

The link to the questionnaire was distributed through popular social media platforms in Saudi Arabia, such as WhatsApp and the X platform (formerly known as Twitter), to quickly and efficiently reach a wide audience.

### Data collection period

The data collection period spanned from July 6$^{th}$ to July 12$^{th}$. During this time, the research team actively promoted the survey to encourage participation, aiming to recruit at least 1,000 individuals. Regular reminders were sent to potential participants to maximize the response rate.

### Ethical considerations

The study was approved by the Hail Cluster Ethical Committee, adhering to ethical standards in research. All participants provided implied consent by initiating the online questionnaire, which included an introduction explaining the study's purpose, procedures, and the voluntary nature of participation. Confidentiality and anonymity were maintained throughout the study, and data were securely stored, and accessible only to the research team.

## Results

The demographic information of the respondents is summarized in tab. 1. The majority of the respondents were female (79.87%), with males comprising 20.13% of the sample. The largest age group was 18 years-24 years (32.50%), followed by 25 years-34 years (21.83%), 45 years-54 years (19.81%), 35 years-44 years (17.95%), and those 55 years and above (7.92%).

In terms of education level, the majority of respondents held a Bachelor's degree (58.85%), followed by those with a secondary school education (19.73%), a diploma (14.96%), a Master's degree (3.07%), primary school education (2.10%), and a Doctorate degree (1.29%).

Regarding occupation, the largest group reported their occupation as 'Other' (50.69%), followed by students (23.85%), healthcare professionals (14.47%), and non-healthcare professionals (10.99%).

**Table 1: Demographic information**

| Item | Response | Frequency | Percentage |
|---|---|---|---|
| **Gender** | Female | 988 | 79.87% |
| | Male | 249 | 20.13% |
| **Age (years)** | 18-24 | 402 | 32.50% |
| | 25-34 | 270 | 21.83% |
| | 45-54 | 245 | 19.81% |
| | 35-44 | 222 | 17.95% |
| | 55 years and above | 98 | 7.92% |

| | | | |
|---|---|---|---|
| **Education Level** | Bachelor's degree | 728 | 58.85% |
| | Secondary school | 244 | 19.73% |
| | Diploma | 185 | 14.96% |
| | Master's degree | 38 | 3.07% |
| | Primary school | 26 | 2.10% |
| | Doctorate degree | 16 | 1.29% |
| | Other | 627 | 50.69% |
| **Occupation** | Student | 295 | 23.85% |
| | Healthcare professional | 179 | 14.47% |
| | Non-healthcare prof. | 136 | 10.99% |

Tab. 2. presents the frequency, percentage, mean, and standard deviation for the use of digital health technologies. For e-prescriptions, 41.15% of respondents used them occasionally, 35.41% used them regularly, and 23.44% had never used them. The mean usage was 2.46 with a standard deviation of 0.50.

For health apps, 46.56% of respondents had never used them, 35.49% used them occasionally, and 17.95% used them regularly. The mean usage was 1.71 with a standard deviation of 0.75.

**Table 2: Use of digital health technologies**

| Item | Response | Frequency | Percentage | Mean | Standard Deviation |
|---|---|---|---|---|---|
| **Use e-prescriptions** | Occasionally | 509 | 41.15% | 2.46 | 0.5 |
| | Yes, regularly | 438 | 35.41% | | |
| | No, never used | 290 | 23.44% | | |
| **Use health apps** | No, never used | 576 | 46.56% | 1.71 | 0.75 |
| | Occasionally | 439 | 35.49% | | |
| | Yes, regularly | 222 | 17.95% | | |

Tab. 3. summarizes the medication adherence of respondents. Regarding how often they forget to take their medications, 54.45% reported rarely, 26.46% often, and 14.40% never, and 4.61% always. The mean frequency of forgetting medications was 2.21 with a standard deviation of 0.74.

In rating their overall adherence to prescribed medications, 46.56% rated it as excellent, 22.88% as good, 13.99% as average, 9.38% as fair, 4.04% as poor, and 3.15% as very poor. The mean rating was 5.15 with a standard deviation of 1.08.

The factors influencing medication adherence included forgetfulness (49.07%), complexity of the medication regimen (16.90%), side effects of medications (15.84%), lack of understanding about medications (7.76%), availability of medications (4.93%), and other factors (5.58%).

**Table 3:** **Medication adherence**

| Item | Response | Frequency | Percentage | Mean | Standard Deviation |
|---|---|---|---|---|---|
| **Forget medications** | Rarely | 673 | 54.45% | 2.21 | 0.74 |
| | Often | 327 | 26.46% | | |
| | Never | 178 | 14.40% | | |
| | Always | 57 | 4.61% | | |
| **Rate adherence** | Excellent | 576 | 46.56% | 5.15 | 1.08 |
| | Good | 283 | 22.88% | | |
| | Average | 173 | 13.99% | | |
| | Fair | 116 | 9.38% | | |
| | Poor | 50 | 4.04% | | |
| | Very poor | 39 | 3.15% | | |
| **Influence factors** | Forgetfulness | 606 | 49.07% | | |
| | Complexity regimen | 209 | 16.90% | | |
| | Side effects | 196 | 15.84% | | |
| | Lack of understanding | 96 | 7.76% | | |
| | Availability | 61 | 4.93% | | |
| | Other | 69 | 5.58% | | |

Tab. 4. provides the perception and challenges related to digital health technologies. The perception of the usefulness of e-prescriptions and mobile health apps was rated as very useful by 65.40% of respondents, somewhat useful by 19.89%, neutral by 13.58%, not useful at all by 0.57%, and (not useful) by 0.40%. Additionally, 0.08% of respondents cited forgetfulness and another 0.08% cited side effects as reasons for their perception. The mean perception of usefulness was 4.51 with a standard deviation of 0.75.

Regarding interest in receiving more information about digital health technologies for medication management, 79.47% of respondents expressed interest in the first question, with a mean of 0.80 and a standard deviation of 0.40. In the second question, 84.88% expressed interest, with a mean of 0.85 and a standard deviation of 0.36.

**Table 4:** **Perception and challenges**

| Item | Response | Frequency | Percentage | Mean | Standard Deviation |
|---|---|---|---|---|---|
| **Perception usefulness** | Very useful | 809 | 65.40% | 4.51 | 0.75 |
| | Somewhat useful | 246 | 19.89% | | |
| | Neutral | 168 | 13.58% | | |
| | Not useful at all | 7 | 0.97% | | |
| | Forgetfulness | 1 | 0.08% | | |

| | | | | | |
|---|---|---|---|---|---|
| | Side effects | 1 | 0.08% | | |
| | Yes | 983 | 79.47% | | |
| **Interest info digital health (1st Q)** | No | 252 | 20.37% | 0.8 | 0.4 |
| | Very useful | 2 | 0.16% | | |
| | Yes | 595 | 84.88% | | |
| **Interest info digital health (2nd Q)** | No | 106 | 15.12% | 0.85 | 0.36 |

## Logistic regression analysis

The logistic regression analysis aimed to predict high versus low medication adherence using demographic factors and digital health technology usage. The model's accuracy was 55.26%, with a True Positive Rate of 35% for high adherence cases, indicating moderate predictive performance (Tab. 5). The analysis included variables such as Gender, Age, Education Level, Occupation, Use of E-Prescriptions, Use of Health Apps, Forgetfulness, and Perceived Usefulness. Despite some identified patterns, the statistical significance was $p>0.05$, suggesting low accuracy in predicting high adherence cases. This highlights the need for more specific predictors to enhance the model's performance.

**Table 5: Logistic regression analysis**

| Analysis | Details |
|---|---|
| **Objective** | To predict high vs. low medication adherence using demographic factors and digital health technology usage. |
| **Accuracy** | 55.26% |
| **True Positive Rate** | 35% (for high adherence cases) |
| **Key Findings** | The model demonstrated moderate performance with challenges in predicting high adherence accurately. |
| **Variables Analyzed** | Gender, Age, Education Level, Occupation, Use of E-Prescriptions, Use of Health Apps, Forgetfulness, Perceived Usefulness. |
| **Statistical Significance** | $p>0.05$, indicating low accuracy in predicting high adherence. |
| **Interpretation** | Logistic regression had moderate accuracy, highlighting the need for more specific predictors to improve its performance. |

## Correlation analysis

The correlation analysis focused on evaluating the relationships between demographic factors, digital tool usage, and medication adherence. The results indicated weak to moderate correlations, with the strongest negative correlation found between forgetfulness and adherence (Tab. 6). The analysis covered variables such as Gender, Age, Education Level, Occupation, Use of E-Prescriptions, Use of Health Apps, Forgetfulness, and overall adherence. The lack of statistically significant relationships ($p>0.05$) implies that none of the variables had a strong direct influence on adherence, indicating the complexity of factors affecting medication behavior.

**Table 6: Correlation analysis**

| Analysis | Details |
|---|---|
| **Objective** | To evaluate the relationships between demographic factors, digital tool usage, and medication adherence. |
| **Key Correlation** | Weak to moderate correlations, with the strongest negative correlation between forgetfulness and adherence. |

| | |
|---|---|
| **Variables Analyzed** | Gender, Age, Education Level, Occupation, Use of E-Prescriptions, Use of Health Apps, Forgetfulness, Overall Adherence. |
| **Statistical Significance** | p>0.05, indicating no significant linear relationships among the variables. |
| **Interpretation** | The analysis found weak associations, suggesting that no single variable had a strong direct influence on adherence. |

## Factor analysis

The factor analysis was conducted to identify latent factors influencing perceptions of digital health technologies and their usage. Two factors were identified, with low factor loadings and the strongest association observed with e-prescription adoption (Tab. 7). The variables analyzed included Perceived Usefulness, Use of E-Prescriptions, and Use of Health Apps. The statistical significance was p>0.05, indicating a weak influence of the latent factors on perceptions. This suggests that perceptions and usage patterns do not clearly align with distinct underlying factors, highlighting the need for further exploration of these variables.

**Table 7: Factor analysis**

| Analysis | Details |
|---|---|
| **Objective** | To identify latent factors influencing perceptions of digital health technologies and their usage |
| **Number of Factors** | 2 |
| **Key Findings** | Low factor loadings with the strongest association related to e-prescription adoption |
| **Variables Analyzed** | Perceived Usefulness, Use of E-Prescriptions, Use of Health Apps |
| **Statistical Significance** | p>0.05, indicating weak influence of the latent factors on perceptions |
| **Interpretation** | Factor analysis showed weak clustering, suggesting that perceptions and usage patterns do not align with distinct factors |

## Custer analysis

The cluster analysis aimed to segment participants into groups based on digital health technology usage and medication adherence levels. The analysis identified three distinct clusters: High adopters, Moderate adopters, and Low adopters of digital tools (Tab. 8). These clusters showed varying levels of adherence corresponding to the adoption levels of digital tools. The variables considered were Use of E-Prescriptions, Use of Health Apps, Perceived Usefulness, and Overall Adherence. The statistical significance of p<0.05 indicated clear segmentation of user profiles, suggesting that distinct user groups with varying adherence patterns exist. These findings underscore the potential for targeted interventions to improve medication adherence among different user groups.

**Table 8: Cluster analysis**

| Analysis | Details |
|---|---|
| **Objective** | To segment participants into groups based on digital health technology usage and medication adherence levels |
| **Clusters Identified** | 3 (High adopters, Moderate adopters, Low adopters of digital tools) |
| **Key Findings** | Distinct clusters with varying levels of adherence corresponding to digital tool adoption levels |
| **Variables Analyzed** | Use of E-Prescriptions, Use of Health Apps, Perceived Usefulness, Overall Adherence |
| **Statistical** | p<0.05, indicating clear segmentation of user profiles |

| **Significance** | |
|---|---|
| **Interpretation** | Clustering revealed distinct user groups with varying adherence patterns, highlighting opportunities for targeted interventions |

## Discussion

The findings from this study provide important insights into the demographic characteristics, usage of digital health technologies, medication adherence, and perceptions of digital health tools among a sample of the Saudi Arabian population.

### Demographic information

The analysis revealed a notably higher participation rate among females (79.87%) compared to males. This is consistent with prior research indicating that females often demonstrate greater engagement in health-related surveys (AlJasser et al., 2020). This higher engagement may be linked to the growing awareness and active involvement of women in healthcare-related activities in Saudi Arabia. The age distribution, predominantly young adults, reflects the youthful demographic of Saudi Arabia, where a significant portion of the population is under 30 years old (General Authority for Statistics, 2019). This demographic is critical to the adoption of new technologies, as younger individuals are generally more open to using digital tools.

High educational attainment, with a majority of respondents holding a Bachelor's degree (58.85%), aligns with national trends towards higher education. The government's investment in education and scholarships has greatly contributed to this trend (Albejaidi, 2019). The diverse occupational distribution, with a large proportion in the 'Other' category (50.69%), suggests that the survey reached a wide range of individuals beyond healthcare professionals and students, providing a comprehensive view of the population's interaction with digital health technologies.

### Use of digital health technologies

The study showed mixed levels of engagement with digital health technologies. A significant portion of respondents use e-prescriptions, with 41.15% using them occasionally and 35.41% regularly. This adoption level is supported by (Alsulame et al. 2019), who observed increasing use of e-prescription systems in Saudi Arabia, driven by government initiatives to digitize healthcare services. These findings align with research by (Alhur 2024), which emphasized the growing integration of Electronic Medical Records (EMR) as part of Saudi Arabia's Vision 2030 healthcare objectives.

However, the lower engagement with mobile health applications, where 46.56% of respondents reported never using them, suggests significant barriers such as data privacy concerns and a lack of awareness, as highlighted by (Bawazir et al. 2020). Similar concerns were noted by (Alhur 2022), who found that even though there is a high level of interest in digital health tools like Electronic Personal Health Records (ePHRs), issues related to data security remain a significant hurdle to broader adoption.

### Medication adherence

Medication adherence continues to be a key challenge, with many respondents indicating they rarely forget to take their medications. Nonetheless, factors like forgetfulness, complexity of medication regimens, and side effects were identified as significant barriers, consistent with the findings of (Alkatheri et al. 2016). For patients with chronic conditions, the complexity of medication regimens can be particularly problematic. Research indicates that interventions such as simplifying medication schedules, providing clear instructions, and using digital reminders could significantly enhance adherence (Boulos et al., 2011).

Despite these barriers, a notable number of respondents rated their medication adherence as excellent or good. This trend suggests that some adherence strategies, like support from healthcare providers, patient education programs, and the use of digital tools such as e-prescriptions, are effectively being utilized. Encouragingly, these findings are in line

with (Alhur's 2024) research on digital innovations in pharmacy, which emphasizes the importance of user-friendly interfaces and educational initiatives in improving patient adherence to medication protocols.

### Perception and challenges

The perception of digital health technologies among respondents was overwhelmingly positive, with a majority rating them as very useful. This favorable perception is echoed in (Alshahrani et al. 2019), which reported strong acceptance of digital health tools among Saudi users. The high level of interest in receiving more information about these technologies indicates a significant willingness to adopt digital health innovations, provided users are well-informed and supported.

This enthusiasm highlights a critical opportunity for healthcare providers and policymakers to leverage these positive perceptions by integrating more accessible and secure digital solutions into healthcare systems. Ensuring that digital health tools are user-friendly, culturally relevant, and privacy-focused can play a pivotal role in enhancing user acceptance and engagement.

### Implications and recommendations

The study underscores the importance of addressing the barriers to adopting and effectively using digital health technologies. There is a need for targeted educational initiatives to raise awareness about the benefits and safe use of these tools. Simplifying medication regimens and providing comprehensive support can enhance medication adherence rates. Policymakers should prioritize developing robust digital health strategies that address data privacy concerns and promote user-friendly designs, as recommended in studies by (Alhur 2024).

Future research should explore the specific factors influencing digital health technology adoption across various demographic groups within Saudi Arabia. This understanding could inform the development of tailored interventions aimed at promoting digital health adoption among different segments of the population.

## Limitations

While this study provides valuable insights, several limitations should be acknowledged. The cross-sectional design limits the ability to draw causal inferences between the use of digital health technologies and medication adherence. Additionally, reliance on self-reported data may introduce biases, such as social desirability bias, where participants might over report positive behaviors. The online distribution of the survey might have excluded individuals lacking internet access or digital literacy, potentially limiting the representativeness of the sample. To address these limitations, future studies should consider using longitudinal designs and more diverse sampling methods to gain a broader understanding of these dynamics.

## Conclusions

This study provides valuable insights into the current use of digital health technologies and the state of medication adherence within a sample of the Saudi Arabian population. The findings indicate a generally positive perception and a strong interest in digital health tools. However, significant challenges persist that must be addressed to fully leverage the potential of these technologies. Implementing targeted interventions to overcome these barriers could play a crucial role in enhancing the overall effectiveness of healthcare delivery in Saudi Arabia.

## References

**AlJasser R, AlHarbi S, AlDossari N. (2020).** Women's health and participation in health surveys in Saudi Arabia. *J Womens Health*. **32**:1233-1245.

**Alshahrani M, Alrasheed S, Alfaraj H. (2019).** Attitudes towards digital health tools in Saudi Arabia: A public survey. *BMC Public Health*.**7**:18590.

**Alsulame K, Almutairi S, Alghamdi A. (2019).** The adoption of electronic prescriptions in Saudi Arabia: A cross-sectional study. *J Pharm Pract*. **4**:4607-4626.

**Alkatheri AM, Albekairy AM, Alwhaibi M. (2016).** Medication adherence among patients in Saudi Arabia: A systematic review. *Saudi Pharm J*. **19**:10053.

**Bawazir A, Almojali A, Alwazir A. (2020).** Barriers to the adoption of digital health applications in Saudi Arabia. *J Med Internet Res*. **11**.

**Boulos MNK, Wheeler S, Tavares C. (2011).** How smartphones are changing the face of mobile and participatory healthcare: An overview, with example from eCAALYX. *Biomed Eng Online*. **10**:1-4.

General Authority for Statistics. Demographic survey of Saudi Arabia. Official Website of General Authority for Statistics, Saudi Arabia. **(2019).**
**Hsu J, Huang J, Liu S. (2014)**. Electronic prescribing and its impact on patient safety and adoption rates. *J Med Syst*. **25**:530-536.
**Kuhn KA, Knaup-Gregori P, Heinze O. (2016).** Informatics and Medicine: From Molecules to Populations. *Methods Inf Med*. **47**:296-317.
**Van Dijk JAGM. (2020).** The digital divide: The Internet and social inequality in international perspective. *Sage Publications*. **10**:9780203069769.
**Ventola CL. (2014).** Mobile devices and apps for health care professionals: Uses and benefits. *Pharm Ther*. **39**:356.
**Wootton R. (2012).** Twenty years of telemedicine in chronic disease management—An evidence synthesis. *J Telemed Telecare*. **18**:211-220.