



## RESEARCH PAPER

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## Utilizing information technology and mobile health applications to improve drug-drug interaction awareness in Saudi Arabia

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### Abstract

Information technology and mobile health (mHealth) applications play a significant role in the healthcare sector of Saudi Arabia. Drug-drug interaction (DDI) awareness is crucial to the patient safety. This study aims to explore the role of information technology and mHealth applications in enhancing DDI awareness among the Saudi population. A cross-sectional survey design adopts to evaluate the effectiveness of information technology and mobile health (mHealth) applications to the awareness about drug-drug interactions (DDIs) in Saudi Arabia taking adequate ethical approval of the concerned authority. The findings in relation to the utilization of information technology and mobile health applications need to improve drug-drug interaction (DDI) awareness in Saudi Arabia. Participant consent and diverse demographic representation with high rate suggest a significant awareness and acceptance of digital health tools among the Saudi population.

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## Introduction

In the rapidly evolving landscape of healthcare, the integration of information technology and mobile health (mHealth) applications is revolutionizing the way health information is accessed and managed. This is particularly relevant in the context of Saudi Arabia, where the healthcare system is undergoing significant digital transformation. A critical aspect of this transformation is the utilization of these technologies to improve drug-drug interaction (DDI) awareness. DDIs pose a significant risk to patient safety, especially in countries like Saudi Arabia, where the prevalence of chronic diseases is increasing, leading to higher rates of polypharmacy.

Multiple studies in KSA indicated that the KSA population has a high level of acceptance of technology particularly in healthcare (Alhur, 2023a, 2023b; Alhur, 2022; Alhur and Alhur, 2022; Alhur, 2023; Alhur, 2023; Alhur, 2021; Alhur *et al.*, 2023). Also, in 2008 Altuwajiri discussed the potential and challenges of implementing e-health in Saudi Arabia, providing a foundational understanding of the health technology landscape in the country (Altuwajiri, 2008). A study in 2019 focused on the adoption of Electronic Health Records (EHRs) in Saudi Arabia, highlighting the critical role of digital solutions in the healthcare management (Alshahrani *et al.*, 2019).

Cresswell and Sheikh's interpretative review provides insights into the organizational challenges in implementing health IT, relevant to understanding the Saudi context (Cresswell and Sheikh, 2013). Moreover, an investigation into the role of mHealth and online educators in promoting health awareness is crucial for understanding DDI awareness through digital platforms (Anshari and Almunawar, 2016).

Fiol *et al.*'s study emphasizes the importance of technological aids in preventing adverse drug events, directly relating to DDI awareness (Fiol *et al.*, 2000). Additionally, the research explores the broader impact of health IT on patient safety, providing a foundation for understanding its role in managing DDIs (Alotaibi and Federico, 2017). Researchers also

Highlight the effectiveness of mHealth in improving medication adherence, a key factor in managing DDI (Alsulame *et al.*, 2016).

Researchers in 2021 provided insights into patient acceptance of professional healthcare guidance, relevant to DDI management through mHealth (Malik *et al.*, 2021).

McEvoy and His colleagues evaluated EHR implementation and indicated that a key component of health information technology can enhance DDI awareness (McEvoy *et al.*, 2017). Furthermore, discusses the security aspects of health information exchange, vital for patient trust in using mHealth for the DDI information (Zaidan *et al.*, 2015). Moreover, a qualitative study on health IT usage in Saudi primary healthcare provides context for mHealth's role in the DDI awareness (Almaiman *et al.*, 2014).

The primary objective of this research is to evaluate the effectiveness of information technology and mHealth applications in raising awareness about DDIs in Saudi Arabia. It seeks to understand how these digital tools are being utilized, the level of awareness they foster among users, and the potential barriers to their effective use in the context of the unique Saudi healthcare landscape.

## Materials and methods

### Research design

This study adopts a cross-sectional survey design to evaluate the effectiveness of information technology and mobile health (mHealth) applications in raising awareness about drug-drug interactions (DDIs) in Saudi Arabia. The survey aims to gather data on awareness, attitudes, and usage of mHealth applications concerning DDIs among the Saudi population.

### Participants

The study targets a diverse demographic of Saudi Arabian residents, including various age groups, genders, educational backgrounds, and employment statuses. Participants are required to be at least 18

years of age. The survey will be distributed across different regions of Saudi Arabia to ensure a representative sample.

#### *Data collection instrument*

The primary instrument for data collection is an online survey, designed to be user-friendly and accessible on various digital platforms. The survey is structured into five parts:

#### *Informed consent*

Participants are provided with detailed information about the study's purpose, what their participation involves, risks, benefits, confidentiality, and voluntary nature of participation. Consent is obtained before proceeding.

#### *Demographic information*

This section collects data on age, gender, educational background, employment status, and region of residence.

#### *Awareness and usage of mobile health applications*

Questions in this section aim to assess participants' familiarity with and frequency of using mHealth applications, along with the purposes for which they use these applications.

#### *Knowledge about drug-drug Interactions*

This part evaluates the participants' self-assessed knowledge level on DDIs and their primary sources of information about DDIs.

#### *Attitudes and perceptions*

This section gathers data on participants' level of concern about DDIs and their perceptions of the effectiveness of mHealth applications in raising DDI awareness.

#### *Data analysis*

The collected data will be analyzed using statistical software. Descriptive statistics will be used to summarize demographic data and responses to survey questions.

#### *Ethical considerations*

The study was approved by the Ethical Approval Committee from the Research Department at Hail Health Cluster No. 2023-129. The study adheres to

ethical standards in research. Participants' confidentiality and anonymity are ensured, with data reported in aggregate form. Participation is voluntary, with the option to withdraw at any point without penalty.

## **Results**

In the study, participants were asked whether they agreed to take part. The response was overwhelmingly affirmative, with 2,334 participants, representing 99.7% of the total, consenting to participate (Table 1). Conversely, a mere 8 participants, accounting for only 0.3% of the total, chose not to participate. This brought the total number of responses to 2,342, ensuring complete participation coverage. The predominant willingness to participate, as indicated by the high percentage of affirmative responses, reflects a strong engagement and interest among the participants in the study.

**Table 1.** Agreement of the participants

Response	Frequency	Percent (%)
Yes	2334	99.7
No	8	0.3
Total	2342	100

The study's participant pool displayed a diverse gender distribution. Of the total participants, 521 were male, which is reflected in the mean and standard deviation values of 1.7786 and 0.41529, respectively (Table 2). The female participants significantly outnumbered the males, with 1,832 individuals participating, accounting for 77.2% of the total. Overall, the combined total of male and female participants was 2,353, making up 99.2% of the study population.

The age distribution among the participants varied. The youngest group, those aged less than 18 years, consisted of 162 participants, representing 6.8% of the total, with a mean and standard deviation of 2.3733 and 0.41529, respectively (Table 2). The most represented age group was 18-24 years, with 1,608 participants, constituting 67.8% of the total. This was followed by the 25-34 years age group with 275 participants (11.6%), the 35-44 years group with 206 participants (8.7%), and the 45-54 years group with 120 participants (5.1%). The total count for all age groups was 2,371, accounting for 99.9% of the participants.

**Table 2.** Demographic information of the participants

Category	Subcategory	Frequency	Percent (%)	Mean/SD
Gender	Male	521		1.7786 / 0.41529
	Female	1832	77.2	
	Total	2353	99.2	
Age	Less than 18	162	6.8	2.3733 / 0.41529
	18-24	1608	67.8	
	25-34	275	11.6	
	35-44	206	8.7	
	45-54	120	5.1	
	Total	2371	99.9	
Educational Level	Primary School	6	0.3	1.6310 / 0.92108
	Secondary School	32	1.3	
	High School	524	22.1	
	Bachelor's Degree	1704	71.8	
	Master's Degree or Higher	100	4.2	
	Total	2366	99.7	

**Table 3.** Awareness and usage of mobile health applications of the participants

Category	Subcategory	Frequency	Percent (%)	Mean/SD
Familiarity with Mobile health applications	Very Familiar	542	22.8	3.7861 / 0.54318
	Somewhat Familiar	1149	48.4	
	Not Very Familiar	572	24.1	
	Not Familiar at All	103	4.3	
	Total	2366	99.7	
Frequency of Using Mobile Health Applications	Daily	184	7.8	2.0997 / 0.79705
	Weekly	335	14.1	
	Monthly	583	24.6	
	Rarely	1023	43.1	
	Never	248	10.5	
	Total	2373	100	

The educational background of participants showed a wide range. Those with primary school education were the least, with only 6 participants, or 0.3% of the total, and a mean and standard deviation of 1.6310 and 0.92108, respectively (Table 2). Participants who completed secondary school were 32 in number, representing 1.3% of the total. High school-educated participants numbered 524, making up 22.1% of the total. The majority of the participants, 1,704 in total, had attained a bachelor's degree, comprising 71.8% of the study population. Additionally, 100 participants, or 4.2% of the total, had a master's degree or higher qualification. The combined total for all educational levels was 2,366, representing 99.7% of the participants.

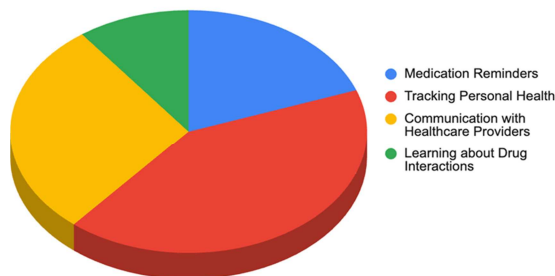
In the study's exploration of awareness and usage of mobile health applications, two key aspects were examined: familiarity with these applications and the frequency of their usage. Regarding familiarity, 542 participants, representing 22.8% of the total, reported

being very familiar with mobile health applications, as indicated by a mean score of 3.7861 and a standard deviation of 0.54318. A larger group, consisting of 1,149 participants or 48.4% of the total, felt somewhat familiar. Those not very familiar numbered 572, accounting for 24.1%, while a smaller fraction of 103 participants, or 4.3%, were not familiar at all. The total number of participants who responded to the familiarity aspect was 2,366, covering 99.7% of the study population (Table 3).

In terms of the frequency of using mobile health applications, 184 participants (7.8%) reported using them daily, with a mean score of 2.0997 and a standard deviation of 0.79705. Weekly usage was reported by 335 participants (14.1%), while monthly usage was noted by 583 participants (24.6%). The largest group, consisting of 1,023 participants (43.1%), used these applications rarely, and 248 participants (10.5%) never used them. In total, responses regarding the frequency of usage were

received from 2,373 participants, ensuring a complete representation of the study's demographic (Table 3).

The findings revealed diverse usage patterns. The most common purpose was for tracking personal health, cited by 41.67% of the participants, indicating a significant focus on self-monitoring and health management. Communication with healthcare providers was another key purpose, utilized by 28.70% of the participants, reflecting the growing trend of digital communication in healthcare settings. Medication reminders were also a notable use, with 19.44% of participants using mobile health applications for this purpose, underscoring the importance of these applications in supporting medication adherence. Additionally, 10.19% of the participants used these applications for learning about drug interactions, highlighting a proactive approach to understanding and managing potential medication risks. These varied uses demonstrate the multifaceted role of mobile health applications in supporting different aspects of health and healthcare (Fig. 1).



**Fig 1.** Purpose of using mobile health applications

In assessing the participants' knowledge about drug-drug interactions, the study revealed a diverse range of self-assessed expertise. A small yet significant portion of the participants, numbering 329 or 13.9%, considered themselves very knowledgeable, with a mean score of 3.3439 and a standard deviation of 1.08753 (Table 4). The largest group, comprising 924 participants or 38.9%, rated themselves as somewhat knowledgeable, indicating a moderate level of understanding. A nearly equal proportion of participants, 862 or 36.3%, perceived themselves as not very knowledgeable, suggesting limited awareness

of drug-drug interactions. Furthermore, 251 participants, accounting for 10.6% of the total, admitted to being not knowledgeable at all. Overall, the total number of participants who responded to this aspect of the survey was 2,373, encompassing the entire study population. This distribution of knowledge levels highlights the varying degrees of awareness and understanding of drug-drug interactions among the participants, pointing to potential areas for educational interventions.

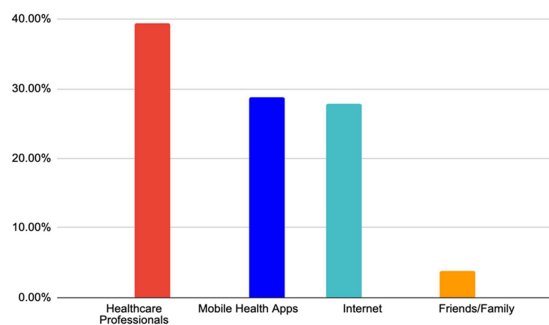
The study also explored the sources from which participants typically obtained information about health. The results indicated a diverse range of sources. Healthcare professionals were the most frequently cited source, with 39.42% of participants relying on them, underscoring the continued importance of traditional medical advice in the digital age. Mobile health applications were also a significant source, used by 28.85% of the participants, reflecting the growing reliance on digital health tools for information and management. The Internet was almost equally utilized, with 27.88% of participants turning to online resources, highlighting the role of the Internet as a readily accessible source of health information. Friends and family were the least cited source, accounting for only 3.85% of the responses, suggesting that while personal networks are valuable, they are less frequently used for obtaining health information compared to professional or digital sources. This distribution of sources indicates a blend of traditional and modern means by which people are informed about health matters.

**Table 4.** Knowledge about drug-drug Interactions

Knowledge Level	Frequency	Percent (%)	Mean/SD
Very knowledgeable	329	13.9	3.3439/ 1.08753
Somewhat knowledgeable	924	38.9	
Not very knowledgeable	862	36.3	
Not knowledgeable at all	251	10.6	
<b>Total</b>	<b>2373</b>	<b>100</b>	

In Fig. 2, the depicted results reveal the various sources from which individuals obtained information

about drug-drug interactions. A significant portion, accounting for 39.42%, relied on healthcare professionals as their primary source. Mobile health applications also played a notable role, with 28.85% of individuals using them for this information. The Internet was almost equally utilized, with 27.88% of respondents seeking information through this medium. Lastly, a small percentage, 3.85%, reported that they received information from friends and family. This distribution highlights the predominant trust in professional and digital sources for health-related information.



**Fig. 2.** Purpose of using mobile health applications Sources of information about drug-drug interactions

**Table 5.** Attitudes and perceptions of the participants

Concern Level	Frequency	Percent (%)	Mean/SD
Very Concerned	336	14.2	2.4374/ 0.85830
Moderately Concerned	838	35.3	
Slightly Concerned	760	32	
Not Concerned	422	17.8	
Total	2356	99.3	

The study delved into participants' attitudes and perceptions regarding drug-drug interactions and the role of mobile health applications in this context. Concerning the level of concern about drug-drug interactions (Table 5), the participants exhibited varied levels of concern. A total of 336 participants, or 14.2%, expressed being very concerned, with a mean score of 2.4374 and a standard deviation of 0.85830. The largest group, comprising 838 y participants (35.3%), felt moderately concerned, while 760 participants (32%) were slightly concerned. Interestingly, 422 participants (17.8%) were not concerned at all, bringing the total to 2,356 respondents who expressed their level of concern, accounting for 99.3% of the study population.

**Table 6.** Perceived effectiveness of mobile health applications

Effectiveness Level	Frequency	Percent (%)	Mean/SD
Very Effective	652	27.5	2.5382 / 0.94466
Somewhat Effective	1113	46.9	
Not Very Effective	472	19.9	
Not Effective at All	95	4	
Total	2332	98.3	

In terms of the perceived effectiveness of mobile health applications in raising awareness about drug-drug interactions (Table 6), 652 participants (27.5%) believed these applications to be very effective, as indicated by a mean score of 2.5382 and a standard deviation of 0.94466. A significant number, 1,113 participants (46.9%), considered them somewhat effective. However, 472 participants (19.9%) found them not very effective, and 95 participants (4%) perceived them as not effective at all. The total number of participants responding to this question was 2,332, representing 98.3% of the total.

**Table 7.** Likelihood of using mobile health applications to learn about drug-drug interactions

Likelihood Level	Frequency	Percent (%)	Mean/SD
Valid			
Very Likely	1055	44.5	2.0043 / 0.80324
Somewhat Likely	1110	46.8	
Not Very Likely	187	7.9	
Total	2352	99.1	

Furthermore, when asked about the likelihood of using mobile health applications to learn about drug-drug interactions (Table 7), a substantial proportion of the participants showed a positive inclination. A total of 1,055 participants (44.5%) stated they were very likely to use these applications, with a mean score of 2.0043 and a standard deviation of 0.80324. Another 1,110 participants (46.8%) considered it somewhat likely, while 187 participants (7.9%) were not very likely to use them. This resulted in a total of 2,352 participants responding to this aspect, covering 99.1% of the study population.

## Discussion

The findings of this study on the utilization of information technology and mobile health applications to improve drug-drug interaction (DDI) awareness in Saudi Arabia offer significant insights into the evolving landscape of healthcare technology. The high rate of participant consent and diverse demographic representation suggest a growing awareness and acceptance of digital health tools among the Saudi population.

The widespread use of mobile health applications for purposes like medication reminders, tracking personal health, and communication with healthcare providers, as indicated by our findings, aligns with the global trend toward digital health solutions. This is particularly relevant in the context of Saudi Arabia, where digital transformation in healthcare is a key focus (Alshahrani *et al.*, 2019). The significant reliance on healthcare professionals and the Internet for health information, as observed in our study, underscores the need for integrating reliable and accessible digital health resources within the existing healthcare framework.

The varied levels of self-assessed knowledge about DDIs among participants highlight an important area for intervention. While a portion of the study population considers themselves knowledgeable, a significant number express limited awareness, aligning with findings in 2003 regarding the importance of technological aids in preventing adverse drug events (Gurwitz *et al.*, 2003). The role of mHealth applications in enhancing medication adherence, as noted by Alsulame *et al.* (2016), further emphasizes the potential of these tools in managing DDIs effectively (Alsulame *et al.*, 2016).

The study's findings on attitudes and perceptions reveal a generally positive inclination towards using mHealth applications for learning about DDIs. This is consistent with the growing acceptance of digital health tools globally. However, the varying degrees of perceived effectiveness and the likelihood of using these applications suggest the need for tailored strategies to enhance user engagement and trust, as discussed by (Alanzi, 2018).

The challenges in implementing health IT, as outlined by Cresswell and Sheikh (2013), are pertinent in the Saudi context (Cresswell and Sheikh, 2013). Addressing organizational challenges, ensuring data security (Zaidan *et al.*, 2015), and enhancing patient trust are crucial for the successful integration of mHealth applications in DDI management. The study by Almaiman *et al.* (2014) on health IT usage in Saudi primary healthcare provides a contextual understanding of these challenges (Almaiman *et al.*, 2014).

This study, while offering valuable insights into the use of information technology and mobile health applications for drug-drug interaction (DDI) awareness in Saudi Arabia, is subject to several limitations. Firstly, its cross-sectional design limits the ability to establish causality or track changes over time. The findings represent a snapshot in time and may not reflect evolving attitudes or practices. Secondly, the reliance on self-reported data could introduce response bias, as participants might overestimate their knowledge or usage of mobile health applications. Thirdly, the sample, although diverse, may not fully represent the entire Saudi population, particularly those in rural or less technologically advanced areas. This could limit the generalizability of the findings. Additionally, the study focuses primarily on the urban population, which might have different levels of access and attitudes toward technology compared to rural areas. Lastly, the rapid pace of technological advancement means that the findings might quickly become outdated, necessitating ongoing research in this area. Despite these limitations, the study provides a crucial starting point for understanding the role of digital tools in enhancing DDI awareness in the context of Saudi Arabia's unique healthcare landscape.

Future research should focus on developing and evaluating targeted educational interventions using mHealth to enhance DDI awareness. Investigating the specific barriers to effective mHealth utilization and exploring patient acceptance of professional healthcare guidance through digital platforms will be crucial for advancing this field.

## Conclusion

This study on the utilization of information technology and mobile health applications in Saudi Arabia offers critical insights into enhancing drug-drug interaction (DDI) awareness, a vital component of patient safety in the context of increasing polypharmacy. Despite certain limitations, such as its cross-sectional design and reliance on self-reported data, the research sheds light on the current state of digital health tool usage and the level of DDI awareness among the Saudi population.

The findings reveal a promising inclination towards the use of mobile health applications for various health-related purposes, including medication management and communication with healthcare providers. This trend underscores the potential of mHealth applications as effective tools in raising awareness and managing DDIs, especially in a digitally evolving healthcare landscape like that of Saudi Arabia.

However, the study also highlights the need for continuous evaluation and adaptation of these digital tools to ensure they meet the evolving needs of users. It emphasizes the importance of addressing barriers to effective utilization, such as technological literacy and access disparities, particularly in rural areas. Furthermore, the study advocates for ongoing research to keep pace with rapid technological advancements and changing user dynamics.

Our study presents a positive outlook on the role of information technology and mHealth in DDI awareness, it also underscores the necessity for strategic, user-centered approaches in the development and implementation of these technologies. By continuing to focus on these areas, there is significant potential to enhance patient safety and healthcare outcomes in Saudi Arabia and beyond.

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