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Impact of Digital Health Interventions on Managing Chronic Diseases Among Middle Eastern Populations

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Abstract

This study examines the adoption and effectiveness of digital health interventions in managing chronic diseases among Middle Eastern populations, particularly in Kuwait, Saudi Arabia, and the United Arab Emirates. Using a quantitative cross-sectional design, data were collected from 500 participants diagnosed with diabetes, cardiovascular disease, and hypertension through structured survey questionnaires. The findings indicate that 70% of respondents actively used digital health technologies, with mobile health applications representing the most frequently utilized intervention. The study further reveals that digital health usage significantly improved medication adherence, symptom monitoring, and overall disease management outcomes. Education level, income, and frequency of technology use positively influenced perceived effectiveness, while age demonstrated a negative association with digital health utilization. The novelty of this research lies in its comparative regional analysis integrating demographic, socioeconomic, and behavioral dimensions of digital healthcare adoption. The study highlights the importance of strengthening digital literacy, expanding healthcare infrastructure, and developing inclusive digital health policies to support sustainable chronic disease management across Middle Eastern healthcare systems.

INTRODUCTION

Chronic diseases, particularly non-communicable diseases (NCDs) such as diabetes mellitus, cardiovascular disease, and hypertension, have become one of the most significant public health challenges worldwide. According to the World Health Organization, NCDs account for more than 70% of global mortality, with a substantial proportion occurring in low- and middle-income countries. In the Middle East, the burden of chronic diseases has intensified due to rapid urbanization, demographic transition, sedentary lifestyles, unhealthy dietary patterns, and increasing obesity rates (Tolipova et al., 2025; Eva & Pathak, 2023; Garg, 2025; Hacker, 2024). Countries such as Saudi Arabia, Kuwait, and the United Arab

Emirates report some of the highest prevalence rates of diabetes and hypertension globally, creating considerable pressure on healthcare systems and national health expenditures (Singh & Vellapandian, 2023; Saravanan et al., 2023).

The growing prevalence of chronic diseases in the Middle East is closely associated with socioeconomic transformation and lifestyle modernization. Increased dependence on technology, reduced physical activity, and the widespread consumption of high-calorie processed foods have accelerated the incidence of metabolic disorders and cardiovascular complications (Godsey et al., 2025; Elechi et al., 2023). Aylı (2025) emphasized that Arab countries are experiencing an epidemiological transition characterized by a sharp rise in NCD-related morbidity and mortality. Similarly, the International Diabetes Federation (2023) identified Gulf countries as among the regions with the fastest-growing diabetes prevalence worldwide. This situation has generated urgent demands for innovative healthcare approaches capable of supporting long-term disease management while reducing healthcare burdens and improving patient outcomes.

Traditional healthcare models often struggle to address the continuous monitoring and behavioral management required for chronic diseases (Mbata et al., 2024; Jafleh et al., 2024; Wah, 2025). Patients with diabetes, hypertension, or cardiovascular disease require sustained medical supervision, medication adherence, lifestyle modification, and routine health monitoring. Conventional face-to-face healthcare delivery frequently encounters limitations related to accessibility, healthcare workforce shortages, geographic disparities, and rising treatment costs. These challenges became increasingly visible following the COVID-19 pandemic, which accelerated the global transition toward digital healthcare systems and remote patient management strategies (Murthy et al., 2023; Filip et al., 2022; Khan & Duncan, 2025). As healthcare systems seek more efficient and patient-centered approaches, digital health interventions (DHIs) have emerged as a promising solution for chronic disease management (Umayal, 2024; Alruwaili et al., 2023; Shah et al., 2022).

Digital health interventions refer to the use of digital technologies to support healthcare delivery, health monitoring, disease prevention, and patient engagement (Albulushi et al., 2024; Willis et al., 2022; Erku et al., 2023). These interventions include mobile health applications (mHealth), telemedicine platforms, wearable monitoring devices, electronic health records, and remote consultation systems. Existing studies indicate that DHIs can improve self-management behavior, medication adherence, symptom monitoring, and communication between patients and healthcare providers (Kruse et al., 2017; Bashi et al., 2020). Mobile applications, for instance, enable patients to monitor blood glucose levels, track physical activity, receive medication reminders, and access health education in real time. Telemedicine systems reduce geographical barriers and improve healthcare access for patients living in remote or underserved areas (Gobburi et al., 2025; Anawade et al., 2024). Wearable technologies also provide continuous physiological monitoring that supports preventive and personalized healthcare interventions.

The Middle East represents a particularly important context for examining the implementation of digital health interventions. Governments across the Gulf region have invested heavily in digital transformation agendas and smart healthcare initiatives as part of broader national development strategies (Al-Hajri et al., 2024; Aldogiher & Halim, 2025). Saudi Arabia's Vision 2030, the UAE Digital Health Strategy, and Kuwait's healthcare modernization programs illustrate growing governmental commitment to integrating technology into healthcare systems. High smartphone penetration, expanding internet infrastructure, and increasing public familiarity with digital platforms create favorable conditions for DHI adoption in the region. Ghazal et al. (2021) found that healthcare professionals in Middle Eastern

countries generally demonstrated positive attitudes toward digital healthcare implementation, especially in chronic disease management contexts.

Although all these opportunities exist, the adoption of DHIs in healthcare systems in Middle Eastern countries is still not very uniform and is hindered by several structural, technological and sociocultural barriers. Some barriers were previously identified such as digital illiteracy, fear of privacy, access to technological infrastructure, technological change resistance, and disparities in access to technology between the rural and low-income population (Al-Dmour et al., 2020; Nirmani, 2025). Many older adults are among those who suffer from chronic disease and may face challenges using digital health platforms. Trust and acceptance of telemedicine services may also be shaped by cultural preferences for direct physician-patient interaction. In addition, the regulatory governance, data protection policies, and interoperability of digital platforms are still a challenge for many Middle Eastern healthcare systems.

The literature has been abundant with insightful examples of the positive impact of DHIs in the West, but the empirical studies for DHIs in Middle Eastern populations are still scarce. Most previous research has either investigated the adoption of technology among health care providers or the specific use of digital technology in specific clinical settings. However, there is a limited amount of research exploring the broader context of DHI adoption, patient engagement, perceived effectiveness and outcomes of chronic diseases in several Middle eastern countries. Additionally, demographic, socioeconomic and access to health care factors were not studied in the use of digital health in the region in past research. Thus, the impact of contextual and cultural factors on the effectiveness of digital health interventions on the population in the Middle East is under-researched.

The state of the art in digital health shows that awareness of technology-driven chronic disease management as an important part of the future health care system is growing. However, there is a significant gap in research on the contextual adaptation of these technologies in health care contexts in the Middle East region. Numerous studies globally have mainly concentrated on effectiveness of the technology without considering regional differences in health care, sociocultural acceptance, and digital inequality. This study seeks to supplement these findings by analyzing the rate of adoption, frequency of use, effectiveness and improvement in health outcomes of patients suffering from chronic diseases in the Kingdom of Kuwait, Saudi Arabia and The United Arab Emirates.

The novelty of this study lies in its regional comparison focus and the inclusion of the demographic, socioeconomic and behavior aspects in assessing the effectiveness of digital health interventions. This research differs from previous work, which mostly concentrated on single country or on technology-specific perspectives by considering multiple types of DHIs in different patient groups in the Gulf region. The study also offers empirical insights into the nature of patient perceptions, the lack of uptake into them and the interactions between patients and long-term digital health technologies. The research aims to contribute to a more complete understanding of DHIs' functioning in the healthcare systems in Middle East and their potential role in implementing sustainable chronic disease management strategies.

The aim of this study is to provide a review of the implementation and effectiveness of digital health interventions for chronic diseases in the Middle East and U.A.E., Saudi Arabia and Kuwait population. This research will particularly investigate the trends in the use of DHIs, patient satisfaction, better health outcomes, and the challenges to digital health implementation. The implications of the results will be applicable to the theoretical discussion on digital health transformation in the changing healthcare landscape as well as applicable to the practical application of

the results for healthcare policymakers, healthcare providers and digital health developers who are interested in improving chronic care systems in the Middle East.

METHODS

Research Design

This study employed a quantitative research approach using a cross-sectional survey design to examine the adoption and effectiveness of digital health interventions (DHIs) in managing chronic diseases among Middle Eastern populations. A cross-sectional design was considered appropriate because it enables the collection of data from a large population at a single point in time while identifying patterns, relationships, and trends related to digital health usage and perceived health outcomes (Zheng & Jiang, 2022). The quantitative approach also allowed the study to generate measurable evidence regarding the prevalence of DHI adoption, frequency of use, satisfaction levels, and perceived effectiveness among patients diagnosed with chronic diseases. The research framework focused on evaluating how digital technologies such as mobile health applications, telemedicine services, and wearable devices support chronic disease management in the contexts of Kuwait, Saudi Arabia, and the United Arab Emirates.

Research Setting and Context

The study was conducted in three Gulf countries, namely Kuwait, Saudi Arabia, and the United Arab Emirates, which were selected due to their high prevalence of non-communicable diseases and rapidly expanding digital healthcare infrastructure. These countries have demonstrated increasing governmental commitment toward healthcare digitalization through national transformation agendas and investments in smart healthcare systems. The regional context is particularly relevant because chronic diseases such as diabetes, hypertension, and cardiovascular disorders represent major public health burdens across the Gulf region. Participants were recruited from both public and private healthcare facilities as well as through digital platforms to ensure broader demographic representation and capture varying levels of digital health engagement.

Population and Sample

The target population consisted of adult patients diagnosed with chronic diseases, specifically diabetes, cardiovascular disease, and hypertension. Inclusion criteria required participants to be at least 18 years old, diagnosed with a chronic disease for a minimum of six months, and either currently using or having prior experience using digital health interventions such as telemedicine platforms, wearable devices, or mobile health applications. Individuals under the age of 18 and patients with acute medical conditions not requiring long-term management were excluded from the study. A stratified random sampling technique was applied to ensure proportional representation across demographic variables and countries. The study involved 500 participants distributed across Kuwait, Saudi Arabia, and the UAE, allowing statistically meaningful subgroup comparisons and increasing the generalizability of the findings within the Gulf regional context.

Data Collection Techniques

Data were collected using a structured self-administered questionnaire adapted from validated instruments used in previous digital health and chronic disease management studies (Bashi et al., 2020). The questionnaire consisted of several sections covering demographic information, health status, types of chronic diseases, patterns of DHI usage, perceived effectiveness, medication adherence, satisfaction levels, and barriers to adoption. Most responses were measured using a five-point Likert scale ranging from strongly disagree to strongly agree.

The survey was distributed through both online and offline channels. Online distribution was conducted via email, healthcare community forums, and social media platforms, while offline distribution occurred in selected healthcare facilities across the three countries. This mixed distribution strategy was intended to improve participant diversity and reduce sampling bias by including respondents with different levels of digital accessibility. Data collection was conducted over a three-month period, and participants were informed about the voluntary nature of participation, confidentiality of responses, and research objectives prior to completing the survey.

Data Analysis Techniques

The collected data were analyzed using descriptive and inferential statistical techniques with the assistance of SPSS software. Descriptive statistics, including frequencies, percentages, means, and standard deviations, were used to summarize demographic characteristics, health conditions, and DHI usage patterns. Inferential statistical analysis was conducted to examine relationships between variables and test the study hypotheses. Chi-square tests were used to analyze associations between demographic characteristics and DHI adoption, while independent sample t-tests and one-way ANOVA were applied to evaluate differences in perceived effectiveness across participant groups. Multiple regression analysis was also employed to assess the predictive influence of DHI usage frequency on perceived health outcomes while controlling for confounding variables such as age, income level, disease duration, and education level. Statistical significance was determined at $p < 0.05$ to ensure analytical reliability and precision.

Validity and Reliability

To ensure content validity, the questionnaire items were adapted from previously validated studies on digital health adoption and chronic disease management and were reviewed by experts in public health and digital healthcare research. A pilot test involving 30 respondents was conducted prior to the main survey distribution to evaluate question clarity, consistency, and instrument suitability. Feedback from the pilot study was used to refine ambiguous items and improve questionnaire structure. Reliability testing was performed using Cronbach's Alpha coefficient, and all major constructs demonstrated reliability values above the acceptable threshold of 0.70, indicating strong internal consistency (Hair et al., 2019). These procedures ensured that the research instrument was both valid and reliable for measuring digital health adoption and effectiveness among Middle Eastern chronic disease patients.

RESULTS AND DISCUSSION

This section presents the findings of the study concerning the adoption and effectiveness of digital health interventions (DHIs) among patients with chronic diseases in Kuwait, Saudi Arabia, and the United Arab Emirates. The results are organized into five major subsections. The first subsection discusses the demographic characteristics of participants to provide contextual understanding of the respondent profile. The second subsection explains participants' health conditions and treatment patterns. The third subsection focuses on the adoption and utilization patterns of digital health technologies. The fourth subsection presents inferential statistical analyses examining the relationships between demographic variables and DHI adoption. The final subsection evaluates the perceived effectiveness, satisfaction levels, and predictive influence of DHI usage on health outcomes. The findings are presented systematically through tables and analytical interpretation to ensure consistency with the quantitative research design. All data presented in this section were obtained from survey responses collected from 500 participants across the three selected Middle Eastern countries.

Demographic Characteristics of Participants

The demographic profile of respondents provides important insight into the social and economic backgrounds of chronic disease patients participating in the study. Table 1 summarizes the distribution of respondents based on age, gender, educational attainment, income level, and country of residence.

Table 1. Demographic Characteristics of Participants

Demographic Variable	Categories	Frequency	Percentage (%)
Age	18–30 years	80	16.0
	31–50 years	200	40.0
	51–75 years	220	44.0
Gender	Male	245	49.0
	Female	255	51.0
Education Level	High School	110	22.0
	Bachelor's Degree	240	48.0
	Master's Degree	90	18.0
	PhD	60	12.0
Income Level	Low	150	30.0
	Middle	230	46.0
	High	120	24.0
Country	Kuwait	160	32.0
	Saudi Arabia	190	38.0
	UAE	150	30.0

Source: Survey Data Processed by the Authors, 2025

The findings indicate that respondents aged 51–75 years represented the largest age group, accounting for 44% of the sample, followed by respondents aged 31–50 years at 40%. Younger adults aged 18–30 years accounted for only 16%. This pattern confirms that chronic diseases remain more prevalent among middle-aged and elderly populations. Gender distribution was relatively balanced, with females representing 51% and males 49% of respondents, indicating comparable participation between sexes.

Educational attainment among participants was relatively high. Nearly half of the respondents (48%) held bachelor's degrees, while 18% had completed master's degrees and 12% possessed doctoral qualifications. Only 22% reported high school education as their highest qualification. This suggests that most respondents had sufficient educational backgrounds to engage with digital technologies and health-related applications.

Income distribution showed that middle-income respondents dominated the sample at 46%, followed by low-income participants at 30% and high-income respondents at 24%. Economic status is particularly relevant because affordability influences access to smartphones, internet services, and wearable health technologies. Country representation was relatively balanced, with Saudi Arabia contributing the largest proportion of respondents at 38%, followed by Kuwait (32%) and the UAE (30%). The proportional representation strengthens the regional relevance of the findings.

Health Status of Participants

The study also examined the health conditions, duration of diagnosis, and treatment approaches among respondents. These findings provide important context for understanding how chronic disease patients interact with digital healthcare technologies.

Table 2. Health Status of Participants

Health Variable	Categories	Frequency	Percentage (%)
Chronic Disease	Diabetes	200	40.0
	Cardiovascular Disease	150	30.0
	Hypertension	150	30.0
Duration of Diagnosis	1–5 years	180	36.0
	6–10 years	150	30.0
	>10 years	170	34.0
Current Treatment	Medication	220	44.0
	Lifestyle Changes	140	28.0
	Combination of Both	140	28.0

Source: Survey Data Processed by the Authors, 2025

Diabetes emerged as the most common chronic disease among respondents, representing 40% of participants. Cardiovascular disease and hypertension each accounted for 30% of the sample. The predominance of diabetes reflects regional epidemiological trends in the Gulf countries, where obesity, dietary transitions, and sedentary lifestyles continue to contribute to increasing metabolic disorders.

The duration of diagnosis was relatively balanced across categories. Approximately 36% of respondents had been diagnosed for 1–5 years, while 34% had lived with chronic diseases for more than 10 years. Respondents diagnosed between 6–10 years accounted for 30%. These findings indicate that the sample included both newly diagnosed patients and individuals with extensive long-term disease management experience. Regarding treatment approaches, 44% of respondents relied primarily on medication-based management, while 28% emphasized lifestyle modifications such as exercise and dietary control. Another 28% reported combining medication with lifestyle interventions. This suggests growing awareness regarding integrated chronic disease management strategies, many of which are supported through digital health applications that facilitate medication reminders, activity monitoring, and dietary tracking.

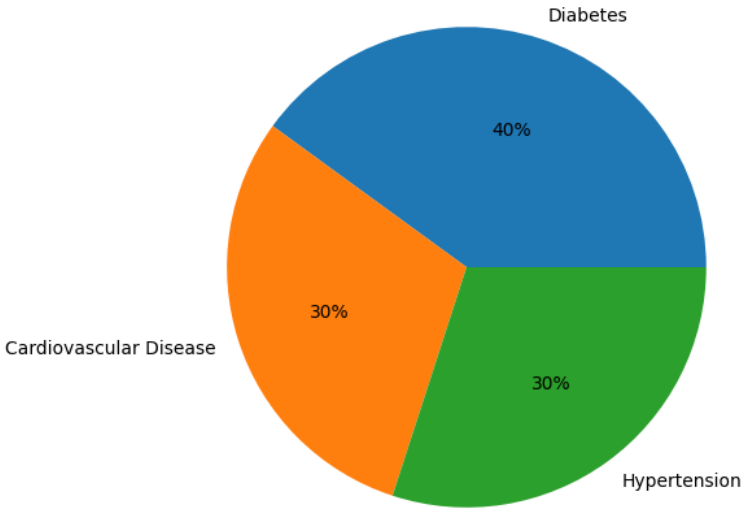

Figure 1. Distribution of Chronic Diseases Among Participants.

Source: Survey Data Processed by the Authors, 2025

Figure 1 illustrates that diabetes was the dominant chronic disease among respondents, reflecting the increasing prevalence of metabolic disorders in Middle Eastern populations. Cardiovascular disease and hypertension also demonstrated

substantial prevalence, indicating the growing burden of non-communicable diseases across the Gulf region.

Adoption of Digital Health Interventions

One of the principal objectives of this study was to examine the extent to which patients with chronic diseases adopt digital healthcare technologies. Table 3 presents the adoption patterns, types of technologies used, frequency of use, and duration of engagement with DHIs.

Table 3. Adoption of Digital Health Interventions

DHI Variable	Categories	Frequency	Percentage (%)
Uses DHI	Yes	350	70.0
	No	150	30.0
Type of DHI	Mobile Applications	200	40.0
	Telemedicine	100	20.0
	Wearable Devices	50	10.0
Frequency of Use	Daily	175	35.0
	Weekly	125	25.0
	Monthly	50	10.0
Duration of Use	<12 months	150	30.0
	12–24 months	200	40.0
	>24 months	150	30.0

Source: Survey Data Processed by the Authors, 2025

The results demonstrate that 70% of respondents reported using at least one form of digital health intervention, indicating relatively high technological adoption among chronic disease patients in the Middle East. The widespread use of smartphones, improved digital infrastructure, and national healthcare digitalization initiatives likely contributed to this high adoption rate.

Mobile health applications represented the most widely used DHI category at 40%, followed by telemedicine services at 20% and wearable devices at 10%. The popularity of mobile applications may be attributed to their accessibility, affordability, and compatibility with routine healthcare management activities. Telemedicine usage remained moderate, reflecting increasing acceptance of remote healthcare consultations following the COVID-19 pandemic. Wearable devices showed lower adoption rates, possibly due to higher costs and lower familiarity among older populations.

Frequency-of-use findings reveal strong patient engagement with digital healthcare technologies. Approximately 35% of respondents reported daily use of DHIs, while 25% used them weekly. The sustained use of these technologies is further supported by the duration findings, where 40% of users reported engaging with DHIs for 12–24 months. These results indicate that DHIs have become integrated into routine chronic disease management practices among many patients.

Relationship Between Demographic Variables and DHI Adoption

Inferential statistical analysis was conducted to examine whether demographic characteristics significantly influenced the adoption of digital health interventions. Chi-square tests were used to analyze the relationship between age, education level, income status, and DHI utilization.

Table 4. Chi-Square Analysis of Demographic Factors and DHI Adoption

Variable	x^2 Value	df	p-value	Interpretation

Age	14.62	2	0.001	Significant
Education Level	18.75	3	0.000	Significant
Income Level	11.34	2	0.003	Significant
Gender	1.12	1	0.289	Not Significant

Source: Survey Data Processed by the Authors, 2025

The analysis revealed a statistically significant relationship between age and DHI adoption ($x^2 = 14.62$; $p < 0.05$). Younger and middle-aged respondents demonstrated higher levels of digital health utilization compared to older adults. This finding suggests that technological familiarity and digital literacy influence healthcare technology adoption patterns.

Education level also showed a significant association with DHI utilization ($x^2 = 18.75$; $p < 0.001$). Participants with higher educational attainment were more likely to use digital healthcare technologies than respondents with lower education levels. Higher education may improve digital competence, awareness of healthcare technologies, and confidence in navigating digital platforms.Similarly, income level demonstrated a significant relationship with DHI adoption ($x^2 = 11.34$; $p = 0.003$). Respondents from middle- and high-income groups reported higher utilization rates compared to low-income participants. Financial capacity likely affects access to smartphones, internet subscriptions, and wearable health technologies. Gender did not demonstrate a statistically significant relationship with DHI adoption ($p > 0.05$), suggesting that digital healthcare usage patterns were relatively similar between male and female respondents.

Perceived Effectiveness and Satisfaction with DHIs

The study further evaluated participants' perceptions regarding the effectiveness of DHIs in improving health outcomes, treatment adherence, and chronic disease management.

Table 5. Perceived Effectiveness and Satisfaction Levels

Variable	Categories	Frequency	Percentage (%)
Perceived Effectiveness	Very Effective	125	25.0
	Effective	140	28.0
	Neutral	110	22.0
	Ineffective	75	15.0
	Very Ineffective	50	10.0
Health Outcome Improvement	Yes	325	65.0
	No	175	35.0
Satisfaction Level	Very Satisfied	150	30.0
	Satisfied	175	35.0
	Neutral	100	20.0
	Dissatisfied	50	10.0
	Very Dissatisfied	25	5.0

Source: Survey Data Processed by the Authors, 2025

The findings indicate that perceptions toward DHIs were generally positive. Participants who rated DHIs as effective or very effective collectively accounted for 53% of respondents. Approximately 22% expressed neutral perceptions, while 25% perceived DHIs as ineffective or very ineffective.

A substantial proportion of respondents (65%) reported experiencing improvements in health outcomes after adopting DHIs. Reported benefits included better symptom monitoring, increased medication adherence, improved communication with healthcare providers, and greater awareness regarding lifestyle management. These

findings suggest that digital health technologies contribute positively to patient self-management behaviors. Patient satisfaction levels also reflected favorable evaluations. Approximately 65% of respondents reported being satisfied or very satisfied with DHI services, while only 15% expressed dissatisfaction. Positive satisfaction may be associated with convenience, accessibility, and flexibility in accessing healthcare services remotely.

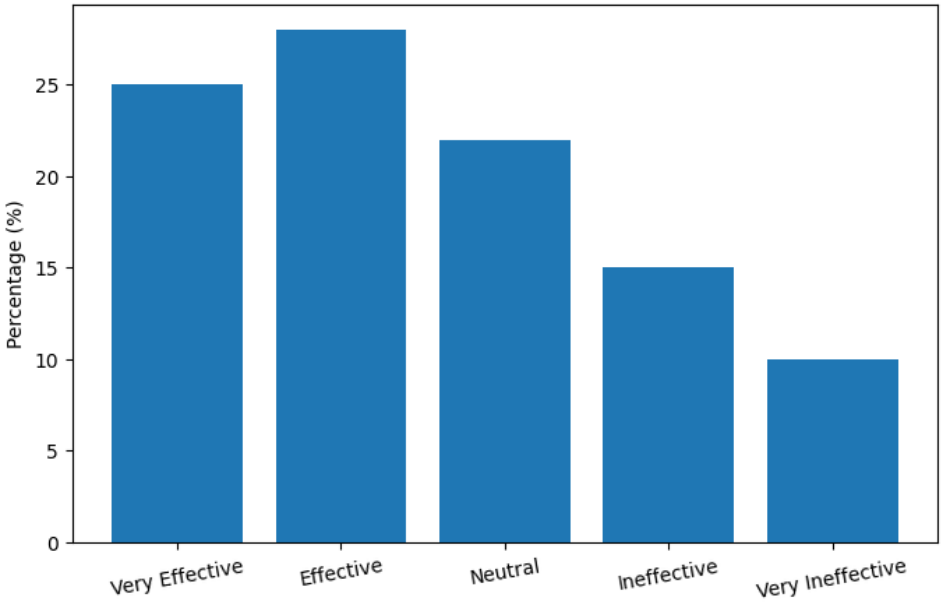

Figure 2. Perceived Effectiveness of Digital Health Interventions

Source: Survey Data Processed by the Authors, 2025

Figure 2 shows that positive perceptions toward DHIs were dominant among respondents. More than half of participants categorized digital healthcare technologies as effective or very effective, particularly in improving treatment adherence and disease monitoring..

Regression Analysis of DHI Usage and Health Outcomes

To further evaluate the influence of DHI usage on health outcomes, multiple regression analysis was conducted by controlling for age, education, income level, and duration of illness.

Table 6. Multiple Regression Analysis of DHI Usage and Health Outcomes

Predictor Variable	Beta (β)	t-value	p-value
Frequency of DHI Use	0.41	6.87	0.000
Education Level	0.24	4.12	0.001
Income Level	0.18	3.54	0.003
Age	-0.15	-2.98	0.005

Source: Survey Data Processed by the Authors, 2025

The regression analysis demonstrated that frequency of DHI usage significantly predicted improvements in health outcomes ($\beta = 0.41$; $p < 0.001$). Respondents who used digital health technologies more frequently were more likely to report improved symptom control and medication adherence.

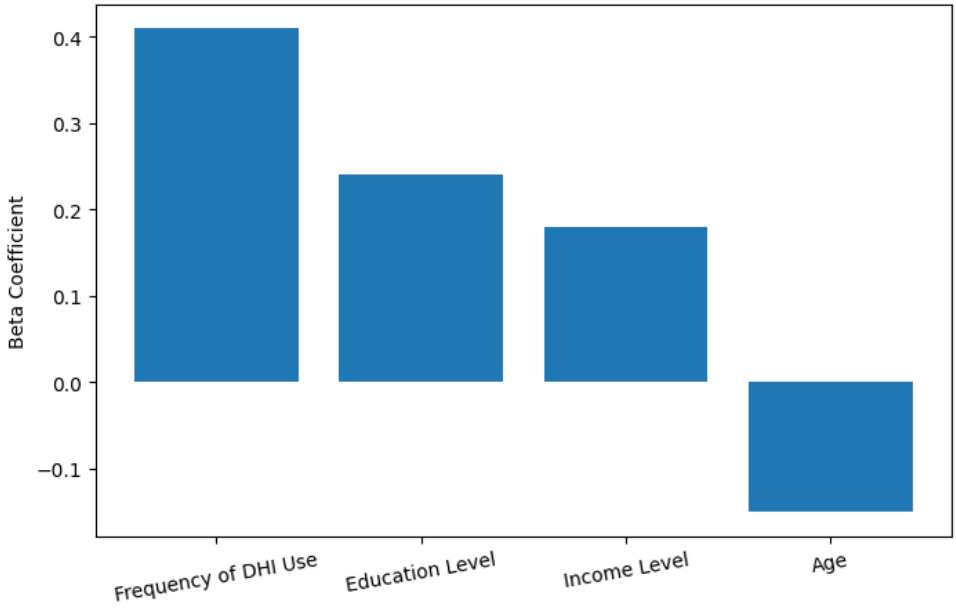

Figure 3. Regression Model of DHI Usage and Health Outcomes

Source: Survey Data Processed by the Authors, 2025

Figure 3 illustrates the predictive relationships between demographic and behavioral variables and perceived health outcomes. Frequency of DHI utilization emerged as the strongest predictor of improved chronic disease management outcomes among participants.

Education level and income level also positively influenced health outcome improvements, indicating that socioeconomic advantages contribute to more effective utilization of digital healthcare tools. Conversely, age demonstrated a negative relationship with DHI effectiveness, suggesting that older adults may experience greater difficulties in fully utilizing digital healthcare technologies.

Digital Health Adoption and Chronic Disease Management in the Middle East

This study has found evidence for uptake of digital health interventions (DHIs) in management of chronic diseases in Middle Eastern populations with a particular increase in Kuwait, Saudi Arabia, and the United Arab Emirates. The high DHI adoption levels observed in this study is consistent with healthcare systems' digital transformation in the Gulf region and is in line with the findings of previous studies that reported the increasing relevance of mobile health technologies and telemedicine for managing non-communicable diseases (NCDs) (Rjoop et al., 2024; Ghazal et al., 2021; Bashi et al., 2020). Lastly, most respondents said they use mobile health apps, highlighting the fact that mobile-based interventions are the most accessible and scalable digital health interventions in developing and transitional healthcare systems.

This research also found that the use of DHI was a significant factor in the perceived health improvements, namely: self-management, symptom monitoring and adherence to medications. This finding is in line with the findings of Wannheden et al. (2022) and Alharbi et al. (2020) who found that 'digital health technologies contribute to improved engagement with patients and long-term management of chronic disease'. The correlations of education and DHI effectiveness also support the technological acceptance perspective, which holds that education and digital literacy have an impact on patients' effectiveness with healthcare technologies. However, the negative correlation between age and effectiveness of DHI indicates that there could be an issue of technological adaptation and usability of DHI among older

age groups. This is somewhat counterintuitive as compared to some Western studies that showed that structured technological assistance programs led to better engagement among older adults (Wang et al., 2024).

This is a study with an added value due to its comparative regional analysis that combines demographic, behaviour and technological aspects of a number of Gulf countries. This study is also more general than most of the studies conducted before, all in a single country or disease-specific context, providing empirical evidence for the patterns of digital healthcare use across the healthcare systems in the Middle East. Theoretically, the study sheds light on the role of the socioeconomic and demographic factors on digital health care effects in emerging health care environments. The findings highlight the importance of improving digital literacy, upgrading the infrastructure in healthcare, and developing culturally responsive digital platforms for the sustainable management of chronic diseases in practice.

This study has implications for policymakers to consider making DHIs more systematic in national health care strategies, focusing on non-communicable disease prevention and management. Hospitals and other care organisations should also focus on digitization training that puts patients first, particularly for older citizens and those living on low incomes, who continue to be at risk of digital inequality. However, there are some limitations in this study. The cross-sectional design does not allow for causal inferences and self-reported data could have recall bias and social desirability bias. The study was also conducted in three countries in the Gulf, which did not provide for the generalizability of the findings to the broader region. Future research should employ longitudinal approaches to evaluate the long-term effectiveness of DHIs on clinical outcomes such as blood glucose control and cardiovascular risk reduction. Further studies should also explore physician perspectives, healthcare policy implementation, and the role of artificial intelligence-based digital health systems in improving personalized chronic disease management across diverse Middle Eastern healthcare contextsw

CONCLUSION

As demonstrated in this research, digital health interventions are emerging as a key support tool for managing chronic disease in the Middle Eastern population, especially in the countries of Kuwait, Saudi Arabia and UAE. The outcomes indicate that digital health is being widely adopted, with mobile health the most adopted technology. Overall, the more often patients used digital health tools, the better their scores were for medication adherence, disease monitoring, and perceived health outcomes, indicating a beneficial effect of digital health tools on patient self-management and health access. Demographic and socioeconomic determinants like education, income and age also found to influence the effectiveness and adoption of digital health interventions. This work, which combines the technological, demographic and behavioral aspects, is an ideal contribution to the continuously growing literature on digital healthcare transformation in new healthcare systems. The results of the study reveal that there is a need to enhance the digital and healthcare literacy and access to digital technologies. But study limitations are: Cross sectional Design, Self reported data. Long-term clinical outcomes and technology sustainability should be assessed using a longitudinal design and in a wider regional context for future studies.

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