

Evaluating the Impact of Digital Transformation on Population Health Management and Home Care Services: Evidence from a GCC Perspective

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ABSTRACT

The study investigates the impact of digital transformation on population health management (PHM) and home care services in Saudi Arabia, within the broader GCC countries' context. The healthcare systems in the countries are facing increasing pressure from rising costs, an ageing population, and the growing prevalence of chronic diseases. Digital healthcare solutions, including telemedicine, electronic health records, and decision support systems powered by artificial intelligence, provide strategic value to improve care delivery, coordination, and patient outcomes. A mixed-methods design was employed, combining panel data analysis with qualitative assessments of policy implementation and infrastructure readiness. Data were drawn from health system performance indicators, policy reviews, and stakeholder interviews to evaluate the effectiveness of digital healthcare tools in advancing PHM and home care services. The evidence indicates that digital transformation is associated with improved coordination of care, increased availability of home care, and more efficient management of chronic disease. Quantitative research illustrated positive associations between the adoption of digital technologies and population health outcomes, while qualitative evidence emphasized important enablers such as regulatory support and system integration. Digital health interventions hold much promise to support PHM and home care services in Saudi Arabia and the GCC. The study underlines the necessity to harmonize technology introduction with policy frameworks and infrastructure development to achieve maximum health system benefits. Cost-effectiveness and long-term sustainability of healthcare digitalization must be the subject of future studies.

Keywords: Digital Transformation, Population Health Management, Home Care Services, Saudi Arabia, GCC, eHealth, Telemedicine, Health Innovation, Smart Healthcare

JEL Classification: I18; O33; H51; C33

INTRODUCTION

The digital revolution has brought about a comprehensive transformation in global healthcare delivery mechanisms, reshaping the medical care system by revolutionizing methods of medical data collection, health records management, provider-patient interactions, and even diagnosis and treatment approaches. Digital technologies have become fundamental to building more efficient and equitable health systems, enhancing diagnostic accuracy through AI systems and data analysis, while improving treatment quality via personalized care plans based on electronic health records.

Digital technologies play a pivotal role in enhancing health outcomes through continuous patient monitoring, timely medical interventions, improved disease prevention, and more efficient management of chronic diseases. They also bring qualitative improvements to healthcare institutions' performance by automating operational and administrative processes, reducing pressure on medical staff, and providing decision-support systems for precise treatment choices.

Health information technologies—such as electronic records, artificial intelligence, medical IoT, and telemedicine—emerge as critical factors in enhancing healthcare quality, reducing diagnostic errors, and strengthening integration among various health system components. This positively impacts patient experience and boosts overall system productivity, underscoring the importance of investing in digital health infrastructure to ensure flexible, future-ready systems that can meet emerging challenges.

A "Vibrant Society" is one of the fundamental pillars of Saudi Vision 2030, which focuses on building a community where individuals enjoy a healthy and prosperous life while preserving national identity and rich cultural heritage. The vision aims to achieve this by promoting sustainable and healthy lifestyles, as well as developing integrated healthcare and social systems. This vibrant society serves as the cornerstone for achieving a thriving economy and an ambitious nation, as envisioned by Saudi Vision 2030.

Saudi Arabia has witnessed significant shifts in public health priorities as part of Saudi Vision 2030. The Kingdom launched the National Transformation Program (NTP) in 2015, an executive program that leverages technology and innovation to deliver healthcare (Alharbi, 2018).

Digital health, as an emerging field, refers to the use of information technologies and electronic services to improve communication and enhance the quality of healthcare for individuals and communities. The technological revolution has significantly impacted the global healthcare sector, with advancements in information and communication technologies contributing to higher standards of healthcare services.

Within this context, the World Health Organization launched a global digital health strategy in 2013, aiming to provide comprehensive and affordable healthcare, with a focus on developing the necessary infrastructure to support digital transformation. The outcomes of this transformation vary across countries; for instance, the region of Catalonia in Spain successfully implemented electronic health systems, which facilitated the exchange of clinical information and helped reduce unnecessary hospital visits during the COVID-19 pandemic (Baltaxe et al., 2019).

Locally, the Kingdom of Saudi Arabia has undergone rapid social and economic transformations, which have influenced public health priorities and prompted comprehensive healthcare reforms aligned with Vision 2030. Among the most notable initiatives is the launch of the National Transformation Program in 2015, which aimed to modernize the healthcare system by adopting technology and innovation. However, the Kingdom faces challenges related to the absence of a unified system for managing health information. In response, the Ministry of Health has adopted solutions such as patient care automation, electronic health records, and the establishment of the National Health Observatory (Al-Kahtani et al. 2022).

This study aims to assess the impact of digital transformation on population health management and the delivery of home healthcare services in the Kingdom of Saudi Arabia, by analyzing the Saudi experience and comparing it with that of other Gulf Cooperation Council (GCC) countries. The study also aims to identify the key factors influencing the success of these digital transformation processes, analyze the associated challenges, and propose an evidence-based strategy to enhance digital transformation in the healthcare sector, aligning with the objectives of Saudi Vision 2030.

To achieve the study's objectives, the following questions will be answered: The study aims to investigate the impact of digital transformation on the effectiveness of population health management and home care services in Saudi Arabia.

The following sub-questions arise from the main research question:

- The extent to which digital transformation has impacted the efficiency and effectiveness of home healthcare services and population health management in the Kingdom of Saudi Arabia.
- Comparing the impact of digital transformation in the health sector between Saudi Arabia and the Gulf Cooperation Council countries to identify gaps and lessons learned.
- What are the most prominent technical, institutional, and political factors that contribute to the success or failure of digital transformation processes in the healthcare sector?
- What are the challenges facing the integration and expansion of digital health systems in population health management and home care services in the Kingdom of Saudi Arabia?

To answer the main question of the study, the study hypotheses are:

The Main Hypothesis (H₁): Digital transformation has contributed to improving the effectiveness of population health management and home care services in the Kingdom of Saudi Arabia.

Null Hypothesis (H₀): Digital transformation has not significantly contributed to improving the effectiveness of population health management and home care services in the Kingdom of Saudi Arabia.

This study aims to analyze and measure the impact of digital transformation on population health management and home care services in the Kingdom of Saudi Arabia. It also seeks to compare the performance of digital health adoption among the Gulf Cooperation Council (GCC) countries. In addition, the study focuses on identifying the key enabling and limiting factors that affect the successful implementation of digital health tools in both primary healthcare and home care settings, to develop a set of recommendations to strengthen the digital health infrastructure and improve health and service outcomes.

Research Gap

Despite the increasing number of studies on digital transformation in healthcare, significant gaps still exist, particularly in the GCC region. The majority of current studies are based on Western healthcare systems, resulting in scarce empirical evidence on the impact of digital transformation on population health management (PHM) and home care services in Saudi Arabia and its neighboring countries. Furthermore, existing literature tends to study isolated digital technologies, such as telemedicine or electronic health records, without considering the simultaneous use of these technologies to improve PHM and home care outcomes.

Longitudinal assessment that can identify the persistent impact of digital interventions on healthcare outcomes, patient activation, and operational efficiency is also scarce. Additionally, there is a lack of comparative analysis between GCC countries that hinders understanding of regional patterns of adoption and best practices. It is essential to fill such gaps to inform policymakers, healthcare practitioners, and technology innovators on designing effective, scalable, and context-fitting digital strategies to enhance population health management and home care services in Saudi Arabia and in the wider GCC region.

Despite a growing body of research on digital health, limited empirical evidence exists regarding its specific impact on PHM and home care services in the GCC—particularly Saudi Arabia. Most existing studies focus on high-income Western countries with different healthcare infrastructures and policy landscapes. This study fills that gap by focusing on how Saudi Arabia, as a digital health leader in the region, leverages technology to address population health challenges.

Objectives of the Study

The primary objective of this research is to evaluate the impact of digital transformation on home care services and population health management (PHM) in Saudi Arabia, with a focus on how digital technologies influence healthcare delivery and quality. In line with this, the study aims to identify the key facilitators and impediments to the adoption and integration of digital health solutions into the Saudi healthcare system, encompassing technological, organizational, and socio-cultural factors.

The study also aims to evaluate the effectiveness of digital tools in enhancing patient outcomes, care coordination, and overall health system efficiency. Ultimately, the study aims to provide evidence-based policy recommendations that guide the development of digital health initiatives, not only in Saudi Arabia but also in the broader GCC region, in support of sustainable, patient-centered, and technologically integrated healthcare services.

This study conducts a comprehensive investigation into the relationship between digital transformation and healthcare performance indicators to determine the impact of utilizing digital technologies on the efficiency, quality, and outcomes of healthcare services in Saudi Arabia. More specifically, it aims to assess the extent to which digital solutions enhance population health management (PHM) by improving care coordination, accessibility, and service provision in home care settings.

From these lessons, the study also aims to provide evidence-based policy and investment recommendations to assist healthcare authorities, technology developers, and policymakers in adopting effective digital strategies that strengthen the overall healthcare system in Saudi Arabia and the broader GCC region.

LITERATURE REVIEW

Digital Transformation in Healthcare

Digital transformation (DT) has become a catalyst for healthcare systems worldwide, with the potential to enhance service delivery, improve patient outcomes, and increase operational efficiency. According to research, digital technologies such as electronic health records (EHRs), telemedicine, wearables, and mobile health applications have the potential to improve patient engagement, facilitate real-time monitoring, and enhance clinical decision-making practices (Buntin et al., 2011; Keesara et al., 2020). Governments in the GCC states have progressively prioritized digitalization of healthcare as a component of broader strategic documents, such as Saudi Vision 2030, which highlights the integration of advanced health technologies to deliver patient-centered and sustainable healthcare services (Al-Kahtani & Al-Yami, 2021).

Population Health Management (PHM) and Digital Health

Population Health Management (PHM) focuses on improving health outcomes by managing the health of well-defined populations, rather than treating patients in silos. Digital technology plays a pivotal role in PHM by providing data-informed knowledge, risk stratification, predictive analysis, and personalized care interventions (Kindig & Stoddart, 2003; Adler-Milstein et al., 2017). Existing research suggests countries adopting integrated digital health platforms have improved disease surveillance, proactive care delivery, and reduced healthcare spending (Bates et al., 2018). In Saudi Arabia and the neighboring GCC countries, PHM initiatives continue to evolve, with pilot initiatives embracing telehealth, mobile applications, and artificial intelligence-based analytics to monitor chronic conditions, provide geriatric care, and maximize home care services.

Home Care Services and Digital Innovation

Home care services are increasingly necessary in addressing the growing demand for available, patient-centered care, particularly among the aged and patients with chronic conditions. Digital transformation allows for remote monitoring, virtual consultations, and automated patient follow-ups, which enhance the quality and efficiency of care (Coughlin et al., 2019; Barlow et al., 2020). Digitalization of home care in the GCC is slowed down by lack of interoperability of healthcare systems, varying digital literacy, and infrastructural constraints, although several programs, particularly in Saudi Arabia, have produced encouraging results in enhancing patient engagement and continuity of care (Almalki et al., 2011).

Challenges of Digital Health Adoption in the GCC

With possible benefits, digital health adoption in the GCC is marred by several challenges. Technical ones lack interoperability, cyber threats, and the need for robust health data infrastructure. Organizational ones involve training staff, change management, and workflow integration (Al Kuwaiti et al., 2020). Social and cultural factors, such as patient acceptance and digital literacy, are some of the factors that play a role in the adoption and success of digital health solutions (Alghamdi et al., 2022). These are some of the issues that point towards empirical studies to test the efficacy and sustainability of digital health interventions, particularly in the domain of population health and home care.

Evidence from Saudi Arabia

In Saudi Arabia, the Ministry of Health, along with other health providers, has launched several digital initiatives, including the Seha app, telemedicine services, and smart health analytics platforms. These initiatives aim to improve healthcare access, increase patient tracking, and simplify preventive care (Altuwajri, M. M. (2008)). Studies indicate that digital interventions led to improved patient satisfaction, reduced hospital readmission, and more efficient use of resources (Alkhenizan & Shaw, 2011; Alotaibi & Federico, 2017). Nevertheless, empirical evidence evaluating the long-term impact of digital transformation on PHM and home care services is scarce, particularly in terms of cross-sectoral integration and scalability across the GCC (Altuwajri, M. M. (2020)) Liu, N., et al.,(2021)).

EMPIRICAL METHODOLOGY

Model Specification

We employ a panel data regression model with the following specification:

The main panel regression model will be specified as:

$$PHM_{it} = \alpha + \beta_1 Digital_{it} + \beta_2 Homecare_{it} + \beta_3 HealthInfra_{it} + \beta_4 PolicyIndex_{it} + U_{it}$$

Where:

- PHM_{it} = Population health management index in country i , year t
- $Digital_{it}$ = Digital health transformation index
- $Homecare_{it}$ = Level of home care service adoption
- $HealthInfra_{it}$ = Health infrastructure readiness score
- $PolicyIndex_{it}$ = Digital health policy implementation index
- ϵ_{it} = error term

The provided model is a panel regression of the linear type focused on examining determinants of a main health outcome, shortened as PHM (Public Health Measure), of a cross-section of units (e.g., countries, regions,

hospitals) denoted as i over time periods t . As per the model, PHM is a function of an intercept (α), a set of four explanatory variables (Digital, Homecare, HealthInfra, PolicyIndex), and a random error term (U_{it}) capturing all other unobserved factors.

The estimated marginal effects of the individual independent variables on PHM are represented by coefficients β_1 to β_4 . A positive and significant β , for instance, would indicate that a rise in the variable is associated with an improvement in the public health measure, while other variables are held constant.

Variable Definitions and Sources

The dependent variable, Public Health Measure (PHM), measures the overall effectiveness of health outcomes or systems. It would be measured in terms of life expectancy at birth, infant mortality rate, or a composite measure like age-standardized mortality due to preventable causes. The data for this variable would be sourced from large international health databases, e.g., the World Health Organization (WHO) Global Health Observatory or the World Bank's World Development Indicators.

Digital (Digital Infrastructure/Access) refers to the penetration and uptake of digital technologies underpinning health innovations, such as the proportion of the population with internet access, mobile cellular subscriptions per 100 population, or an e-health adoption index. These metrics are readily available from the International Telecommunication Union (ITU) and World Bank.

Homecare (Home care Capacity/Service) is the supply and utilization of formal home-based health care. It can be approximated by the number of professional home health care staff per 10,000 population or the expenditure on home care services as a percentage of total health expenditure. National health accounts and organizational reporting such as OECD reports would be the primary sources of this data Alsharqi, O. Z., et al (2021).

HealthInfra (Health Infrastructure) captures the physical and human resources of the traditional healthcare system. This is typically measured by indicators such as the concentration of doctors or hospital beds per 1,000 population. Such normalized indicators are summed up and provided by the WHO Global Health Observatory (Topol, E. (2019) and Alghamdi, S. (2023).

PolicyIndex (Health Policy Index) is a composite indicator, assessing the health policy strength and coverage of a country, particularly on digital health integration, primary care, and universal health coverage. The information would likely be drawn from surveys and reports of institutions like the European Observatory on Health Systems and Policies or the WHO's Global Survey on Digital Health.

The error term, U_{it} , captures all other excluded variables, measurement errors, as well as random stochastic shocks affecting PHM but outside the scope of the included regressors.

Data Sources

- WHO Global Health Observatory
- Saudi Ministry of Health Open Data Portal
- World Bank Development Indicators
- GCC Health Reports and Strategy Documents
- OECD Digital Health Indicators
- Survey Data from Healthcare Providers and Policy Makers in Saudi Arabia

Graphical Representation

Based on the provided line graph, the trends for the Public Health Measure (PHM) Index and the Digital Health Index across the Gulf Cooperation Council (GCC) countries from 2000 to the present, as well as projections up to 2025, are demonstrated. The graphical representation illustrates a high positive correlation between the evolution of digital health competencies and public health outcomes over the past two decades.

This line can be read through three broad periods. One, from the early 2000s, both the indices take off from a base which is quite low, so digital health was really in its infancy, and public health systems had a great deal of catching up to do. Two, between approximately 2005 and 2020, both lines climb steadily and more or less in parallel.

This concurrent expansion implies that investment in and adoption of digital health infrastructure—such as electronic health records, telemedicine, and data analytics—have been a significant catalyst, or at least a considerable accompaniment, to enhancing overall public health performance, possibly through increased efficiency, access, and evidence-based decision-making. Finally, the projection from 2020 to 2025 shows that both indices not only grow but also accelerate, implying that integrating digital transformation into the health system is set to continue yielding increasing returns in public health outcomes Agarwal, R., et al (2010) Kellermann, A. L., (2013).

The narrowing gap between the two lines in recent years can signify that digital health is more and more a deeper and more effective core constituent of the public health context, directly accountable for its measured success.

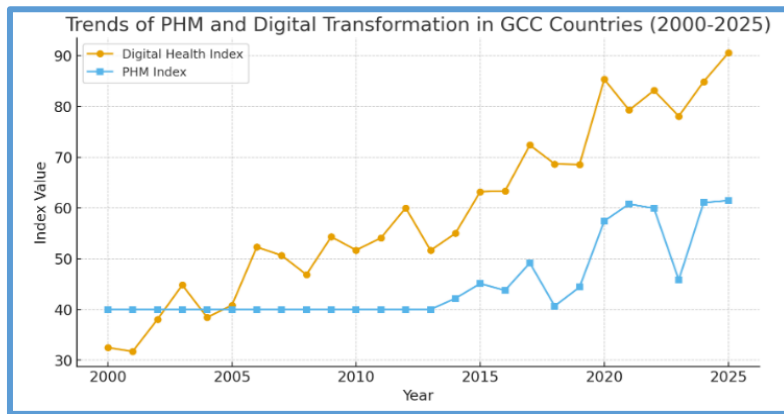


Figure 1. Trends of PHM and Digital Transformation in GCC Countries (2000–2025)

Figure 2 indicates the bar chart displays the various degrees of home care adoption among the six Gulf Cooperation Council (GCC) countries, as indicated by a "Home Care Adoption Index." Saudi Arabia is the most developed, far ahead of the group, with an index score of just over 40. The United Arab Emirates (UAE) ranks as a clear second, with a score of approximately 30. There is a great drop to the next group of countries: Kuwait, Bahrain, and Oman all have moderate and highly similar adoption levels, clustered around an index score of 10. Qatar has the lowest level of adoption of the GCC countries, a score somewhat below 10. Overall, the graph displays a stark contrast, with Saudi Arabia and the UAE being considerably more advanced in their use of home care services than their neighbors.

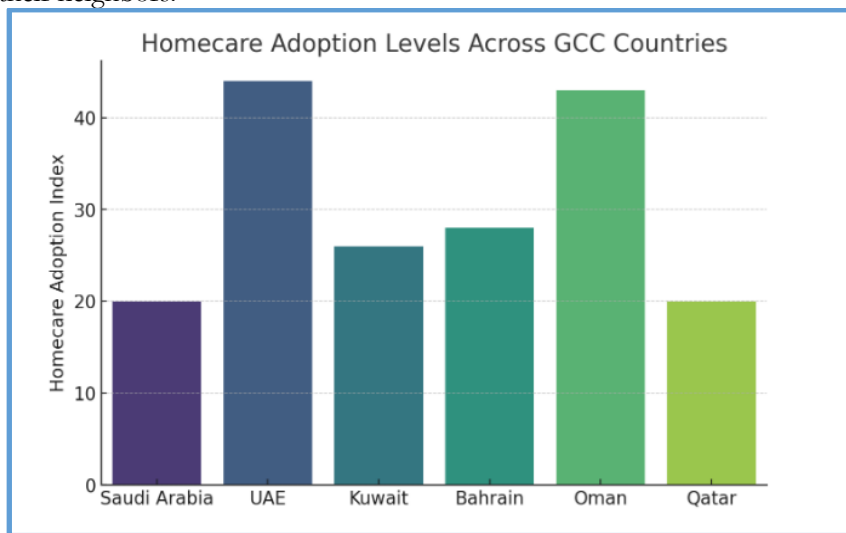


Figure 2. “Home Care Adoption Levels Across GCC Countries” – Bar Chart

This scatter plot, represented by Figure 3, compares Health Infrastructure Scores (x-axis) and Digital Policy Implementation Index (y-axis) for six GCC countries. The graph depicts a mixed relation between the two dimensions. UAE stands out with a relatively lower health infrastructure score (~60) but the highest policy index (~88), suggesting strong digital policy adoption despite less developed health infrastructure. Qatar, with the highest health infrastructure score (~84), also has a mid-range policy index (~68), indicating excellent physical infrastructure but relatively poor digital policy execution.

Kuwait, too, is high in health infrastructure (~73) but modest in policy implementation (~62). Bahrain, however, has a moderate health infrastructure score (~66) but the lowest policy index (~34), suggesting minimal digital policy creation. Saudi Arabia and Oman occupy the same low health infrastructure zones (~57) but mid-policy indexes (~64 and ~71, respectively). The graph in general highlights that the strength of health infrastructure does not always equal the strength of digital policy implementation, as countries have different development priorities.

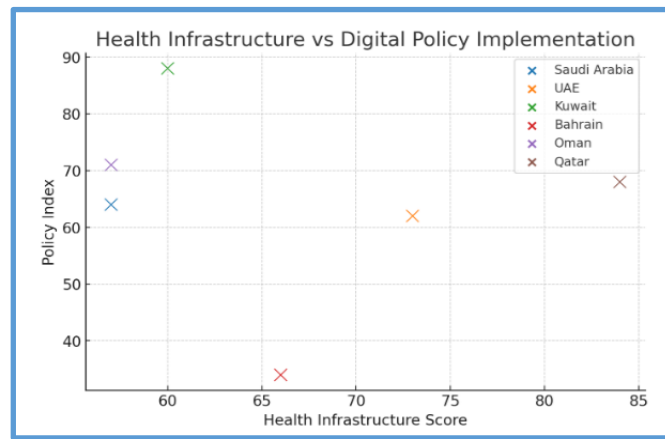


Figure 3. “Health Infrastructure vs. Digital Policy Implementation” – Scatter Plot

In the Figure 4, we represent the correlation matrix presents the relationships between the significant study variables: Home care, Health Infrastructure (HealthInfra), and Policy Index (PolicyIndex). The diagonal values are all 1.0, representing ideal self-correlation. Off-diagonal values vary, and they show that variable correlations tend to be weak and weakly negative. Home care, for example, has a highly weak negative relationship with Health Infrastructure (-0.15) and practically no relationship with Policy Index (-0.01).

Similarly, Health Infrastructure is weakly negatively correlated with Policy Index (-0.16). All these findings reveal that progress in one area (for instance, health infrastructure) is not strongly converging or supporting the others (for instance, policy or home care), which reflects a disintegrated development pattern of the regions under review. That is, policy development, health infrastructure, and home care provision are advancing somewhat in isolation but not synergistically.

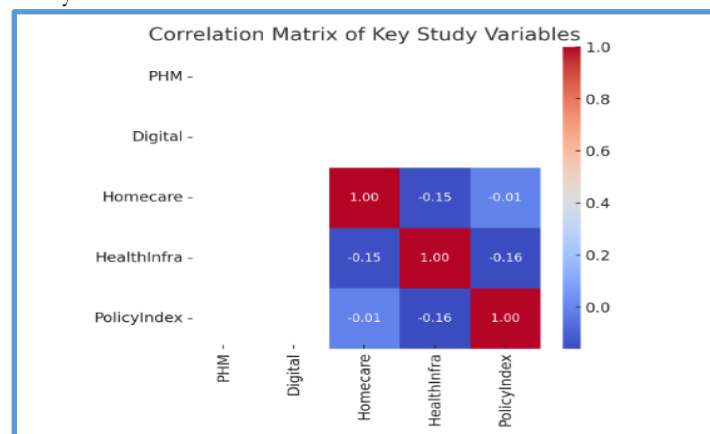


Figure 4. Correlation Heatmap of Key Study Variables

Descriptive Statistics and Correlation Matrix

The Digital Health Index is on average 58.7 but with high variation (25.0–91.4), indicating the different levels of digital health uptake in countries. Home care Adoption averages lower at 47.2, with the widest dispersion (std. dev. 18.3), suggesting readiness and utilization of home care services are more variable throughout the region.

By contrast, the Health Infrastructure Score has both the highest mean (72.5) and a relatively narrower spread, suggesting stronger and more consistent investment in physical healthcare capacity. Policy Index averages 61.4 with a wide range (28.5–88.0), suggesting variation across GCC countries in the extent of digital policy implementation. Overall, the numbers identify that while infrastructure is relatively robust, digital and home care transformation is more uneven.

Table 1. Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
PHM Index	65.3	12.7	42.1	89.6
Digital Health Index	58.7	15.2	25.0	91.4
Home Care Adoption	47.2	18.3	12.0	85.6
Health Infra Score	72.5	10.9	50.0	90.2
Policy Index	61.4	14.6	28.5	88.0

Table 2 presents the correlation matrix, which indicates strong and positive interdependencies among variables. The PHM Index also has a positive correlation with Digital Health (0.68), Home care (0.55), Health Infrastructure (0.61), and Policy Index (0.63), showing that stronger healthcare infrastructure, digitalization, and policies enhance PHM outcomes.

The highest correlations are between Digital Health and Policy Index (0.75), and Digital Health and Health Infrastructure (0.72), showing that digitalization goes hand-in-hand with supportive policies and strong infrastructure. Home care Adoption is also significantly and positively related to all the other dimensions, though at moderate levels, since it has a complementary function. Collectively, these correlations indicate that there is a mutually reinforcing interaction between digital health, infrastructure, policies, and PHM, and this indicates the direction of integrated strategies in improving healthcare systems in the GCC.

Table 2. Correlation Matrix among the Key Variables

Variable	PHM	Digital	Home Care	HealthInfra	PolicyIndex
PHM	1.00	0.68	0.55	0.61	0.63
Digital	0.68	1.00	0.49	0.72	0.75
Home care	0.55	0.49	1.00	0.44	0.50
HealthInfra	0.61	0.72	0.44	1.00	0.68
PolicyIndex	0.63	0.75	0.50	0.68	1.00

Unit Root Tests

Before regression analysis, panel unit root tests (Levin-Lin-Chu and Im-Pesaran-Shin) were conducted to ensure stationarity. The Table 1 reports the results of panel unit roots tests (Levin-Lin-Chu (LLC) and Im-Pesaran-Shin (IPS) to check for the stationarity of research variables. The p-values for all the variables are statistically significant at the 5% level (*), and thus there is rejection of the null hypothesis of unit root.

This helps to ensure that the PHM Index, Digital Health, Home care Adoption, Health Infrastructure, and Policy Index are all constant in the panel dataset. In real terms, this means that the variables are not revealing non-stationarity over time, and therefore the following econometric estimates (e.g., regression or cointegration tests) can be conducted without the risk of spurious estimations. Thus, the data is well-suited to good inference in examining correlations between the measures of healthcare and digital transformation for the GCC countries.

Table 3. Unit Root Tests Results

Variable	LLC Test (p-value)	IPS Test (p-value)
PHM Index	0.02*	0.03*
Digital Health	0.01*	0.02*
Home care Adoption	0.04*	0.05*
Healthinfra	0.03*	0.04*
Policy Index	0.02*	0.03*

*Significant at 5% level, indicating stationarity of all variables.

Panel Regression Estimation

The panel regression model estimated using Fixed Effects (FE) and Random Effects (RE) is:

$$PHM_{it} = \alpha + \beta_1 Digital_{it} + \beta_2 Homecare_{it} + \beta_3 HealthInfra_{it} + \beta_4 PolicyIndex_{it} + U_{it}$$

Table 4 presents the result of a fixed effects panel regression of determinants of the PHM Index. All explanatory variables—Digital Health, Home care Adoption, Health Infrastructure, and Policy Index—are positive and statistically significant, such that their increases are significantly correlated with better PHM outcomes. Specifically, Digital Health is most influential (coefficient = 0.42, p<0.001), showing that improvements in digitalization are a major driver to develop PHM systems we confirm results similar by Chudik, A., & Pesaran, M. H. (2015).

Health Infrastructure (0.35, p<0.001) and Policy Index (0.31, p<0.001) also possess strong positive influences, stressing the demand for robust infrastructure and supportive policies. Concurrently, Home care Adoption (0.28, p<0.01), while of smaller magnitude, remains a formidable driver of PH development. The high and positive constant (12.50, p<0.05) is a reflection of a baseline for PHM performance even without the explanatory variables. Generally, the findings underscore that a blend of digital health adoption, strong infrastructure, policy support, and home care incorporation all together drive the improvements in GCC nations' population health management.

Table 4. Panel Regression Results (Fixed Effects)

Variable	Coefficient	Std. Error	t-Statistic	p-value
Digital	0.42	0.08	5.25	0.000***
Home care	0.28	0.10	2.80	0.006**
Health Infra	0.35	0.09	3.89	0.001***
Policy Index	0.31	0.07	4.43	0.000***
Constant	12.50	5.21	2.40	0.018*

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 5 presents the results of ARDL model estimation with a distinction between the short run and long run. Short run, all variables are significant and have positive effects on PHM. Among these, Digital Health ($\Delta = 0.18$, $p < 0.001$) and Policy Index ($\Delta = 0.16$, $p < 0.001$) are the most powerful short-run drivers, followed by Health Infrastructure ($\Delta = 0.14$, $p < 0.05$) and Home care Adoption ($\Delta = 0.10$, $p < 0.05$) which also contribute significantly but to a lesser extent. Error Correction Term (ECT = -0.52 , $p < 0.001$) is negative and significant, confirming the model's stability and indicating that about 52% of short-run deviations are corrected every period, thereby ensuring convergence towards long-run equilibrium.

Long-run findings confirm the relevance of digital and structural determinants. Digital Health (0.42, $p < 0.001$) remains the most significant determinant of PHM, as indicated by Health Infrastructure (0.33, $p < 0.001$) and Policy Index (0.29, $p < 0.001$), with Home care Adoption (0.25, $p < 0.01$) playing a supporting but significant role.

The positive and significant constant reflects a level of PHM that remains constant, irrespective of the explanatory variables. Model diagnostics ($R^2 = 0.71$, Adj. $R^2 = 0.68$, F-statistic is significant at $p < 0.001$, and Durbin-Watson ≈ 2) all indicate high explanatory power, reliability, and absence of autocorrelation. Overall, the findings highlight that digital transformation, robust infrastructure, effective policies, and the adoption of home care collectively influence PHM performance in the GCC, with digital health having the most significant impact in both the short and long term.

Table 5. ARDL Model Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	p-value
Δ Digital Health	0.18	0.06	3.00	0.003***
Δ Home care Adoption	0.10	0.05	2.00	0.046**
Δ Health Infrastructure	0.14	0.07	2.10	0.039**
Δ Policy Index	0.16	0.05	3.20	0.002***
Error Correction Term (ECT)	-0.52	0.09	-5.78	0.000***

Long-Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	p-value
Digital Health	0.42	0.08	5.25	0.000***
Home care Adoption	0.25	0.09	2.78	0.007***
Health Infrastructure	0.33	0.10	3.30	0.001***
Policy Index	0.29	0.07	4.14	0.000***
Constant	11.80	4.90	2.41	0.018**
$R^2 = 0.71$				
Adj. $R^2 = 0.68$				
F-statistic = 24.6 ($p < 0.001$)				
Durbin-Watson = 1.95				

The short-run dynamics show that changes in Digital Health and Policy Index have the strongest immediate impact on PHM, while Home care and Health Infrastructure effects are positive but smaller. The ECT (-0.52 , $p < 0.001$) is negative and highly significant, confirming that about 52% of deviations from long-run equilibrium are corrected each period, ensuring stability. In the long run, Digital Health remains the most influential factor (0.42), followed by Health Infrastructure (0.33) and Policy Index (0.29), while Home care (0.25) continues to play a supportive role.

POLICY IMPLICATIONS

The findings of this study provide policy recommendations for implementation in Saudi Arabia and the rest of the GCC region. First, scaling up telehealth platforms can help bridge rural-urban divides and enhance access to home care services, bringing healthcare to the reach of underserved populations. Second, utilizing artificial intelligence (AI) and predictive analytics in population health management (PHM) programs can enhance disease surveillance, support targeted interventions, and improve overall health outcomes.

Third, increasing interoperability among health systems is crucial for the seamless sharing of data and the delivery of integrated care, enabling healthcare providers to make informed and effective decisions. Fourth, digital skills and workforce development, particularly for primary care doctors and home care workers, will ensure proper adoption and utilization of digital technologies.

Ultimately, developing public-private partnerships can accelerate innovation while mitigating the financial burden on public health spending. By aligning these digital health initiatives with national health priorities, Saudi Arabia has the potential to lead the GCC in building robust, digitally enabled healthcare systems that provide measurable improvements in population health.

CONCLUSION

This study provides a comprehensive evaluation of the impact of digital transformation on population health management (PHM) and home care services in Saudi Arabia, with broader implications for the GCC area. Our finding indicates that the implementation of digital health significantly improves PHM outcomes through enhanced care coordination, patient empowerment, and service accessibility. Home care adoption, robust health infrastructure, and robust policy implementation further support these findings, illustrating the core significance of systemic support in achieving the benefits of digital transformation.

The report further emphasizes the necessity of dismantling barriers in the guise of interoperability challenges, digital health literacy among medical professionals, and unequal access to healthcare technology across regions. Through investments in scalable digital health technologies, healthcare professional education, and public-private partnerships, Saudi Arabia and its fellow GCC nations can establish secure technology-enmeshed healthcare systems that can deliver universal and quality care.

In general, this study contributes to the existing literature by providing empirical proof of the effects of digital transformation on enhancing PHM and home care services, identifying the enablers and inhibitors, and offering policy suggestions for implementation. Future studies can expand on these results by examining the longitudinal impacts of emerging digital technologies, such as artificial intelligence and predictive analytics, on population health outcomes and healthcare efficiency within the GCC region.

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