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FULL PAPER

The Impact of the Health Transformation Program (Vision 2030) on Health Performance Indicators in Saudi Arabia (2016–2024)

Abstract

Health performance indicators are essential tools for monitoring population health, evaluating system performance, and guiding policy decisions. In Saudi Arabia, these indicators have gained increasing importance as the country undergoes major reforms under Vision 2030 and the Health Sector Transformation Program (HSTP). This study provides a comprehensive quantitative assessment of national health indicators from 2010 to 2024, focusing on changes before and after the implementation of the HSTP in 2016. Using secondary data from the Ministry of Health, WHO, and the World Bank, the analysis employs descriptive statistics, trend analysis, pre–post comparisons, and Interrupted Time Series (ITS) modeling. The results show substantial improvements in life expectancy, infant and maternal mortality, service coverage, digital health adoption, and quality indicators, despite temporary disruptions during the COVID-19 pandemic. However, chronic disease prevalence—particularly diabetes—continues to rise. Overall, the findings demonstrate meaningful progress in modernizing the Saudi health system and advancing digital transformation, while highlighting the need for sustained investment in prevention, primary care, and workforce development.

Keywords.

Health indicators; Vision 2030; Health Sector Transformation Program; Digital health; Interrupted Time Series; Health system performance.

JEL Classification Codes

I10; I18; O33; C22; H51.

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1. Introduction

Saudi Arabia has embarked on an ambitious transformation of its health system through the Health Sector Transformation Program (HSTP), launched in 2016 as a core pillar of Vision 2030 (Vision 2030, 2016). The program aims to restructure the health sector to become more efficient, sustainable, and patient-centered by improving service quality, enhancing preventive care, and expanding access across all regions of the Kingdom.

Before the launch of Vision 2030, the Saudi health system faced several structural challenges, including a high burden of non-communicable diseases and rising healthcare expenditure. According to the World Health Organization, diabetes prevalence reached 18.3% in 2016, while obesity exceeded 33% (WHO Global Health Observatory, 2023). Key health indicators also reflected the need for reform: life expectancy stood at 74.8 years in 2016, under-five mortality was 8.0 per 1,000 live births, and maternal mortality was 17 per 100,000 live births (World Bank, 2023; WHO, 2023).

Since the implementation of Vision 2030, measurable improvements have been observed across several health performance indicators. Life expectancy increased to 76.4 years in 2022, and under-five mortality declined to 6.3 per 1,000 live births (World Bank, 2023). The proportion of primary healthcare centers meeting quality standards rose from 20% in 2016 to more than 80% in 2022 (Vision 2030 Progress Report, 2023). Digital health adoption expanded significantly, with more than 70% of hospitals connected to the national electronic health record platform by 2023, and telemedicine utilization increased from 2.5 million consultations in 2020 to 4.5 million in 2022 (MOH Digital Health Report, 2023).

Despite these advances, empirical research assessing the magnitude and statistical significance of these improvements remains limited. This study provides a systematic, data-driven assessment of the impact of the HSTP on key health performance indicators from 2010 to 2024.

2. Problem Statement

Although the HSTP represents one of the most significant reforms in Saudi Arabia's modern health history, empirical evidence assessing its impact remains limited. Most existing studies are descriptive and do not provide a comprehensive, quantitative evaluation of changes in health outcomes, access to care, preventive services, and system efficiency since 2016. This study addresses this gap by analyzing national health performance indicators from 2010 to 2024, with a focus on evaluating the impact of the HSTP.

3. Study Questions

This study investigates the extent to which the Health Sector Transformation Program (HSTP), launched under Vision 2030, has contributed to measurable improvements in key health performance indicators in Saudi Arabia between 2016 and 2024. Specifically, the study examines how mortality, morbidity, and life expectancy trends have evolved during the transformation period, and evaluates the degree to which access to healthcare services—particularly primary healthcare—has expanded as a result of system reforms. The study also explores the role of digital health adoption, including electronic health records and virtual consultations, in strengthening service quality and enhancing the operational performance of the health system.

4. Study Objectives

The primary objective of this study is to evaluate the impact of the Health Sector Transformation Program on key health performance indicators in Saudi Arabia from 2016 to 2024. To achieve this aim, the research analyzes long-term trends in major health indicators, assesses improvements in access to healthcare services, and examines the contribution of digital health initiatives to overall system performance. Additionally, the study seeks to identify persistent challenges that continue to affect population health outcomes and to propose evidence-based recommendations that can support future policy development and ensure the sustainability of ongoing reforms.

5. Hypotheses

H1: The HSTP has led to significant improvements in key health performance indicators.

H2: Access to healthcare services, particularly primary healthcare, has improved significantly.

H3: Digital health adoption has positively contributed to improvements in system performance.

Literature Review

A substantial body of literature has examined the structure, performance, and challenges of the Saudi health system prior to and during the early phases of Vision 2030. Almalki, Fitzgerald, and Clark (2011) provided one of the most comprehensive assessments of the Saudi healthcare system, highlighting persistent structural issues such as the dominance of hospital-centric care, rising chronic disease burden, and uneven access to services. Their review underscored the need for stronger primary healthcare (PHC), improved governance, and enhanced preventive services—priorities that later became central to the Health Sector Transformation Program (HSTP).

Similarly, El Bcheraoui et al. (2015), using Global Burden of Disease (GBD) data, demonstrated that non-communicable diseases (NCDs) accounted for the majority of morbidity and mortality in Saudi Arabia. Their findings emphasized the urgency of shifting toward prevention, early detection, and integrated chronic disease management, aligning directly with Vision 2030's goals.

Primary healthcare reform has also been widely discussed in the literature. Almalki, Al-Faisal, and Al-Shayea (2017) evaluated PHC performance and identified challenges related to variability in quality, limited standardization, and weak integration with higher levels of care. Their recommendations—expanding PHC capacity, improving workforce competencies, and integrating digital tools—mirror the HSTP's Model of Care. Complementing this, Alharbi (2018) found improvements in patient satisfaction following modernization efforts but noted persistent gaps in staffing and service coordination.

Digital health transformation is another major theme. Househ (2016) reviewed national e-health initiatives and highlighted both opportunities and challenges, including interoperability limitations and workforce readiness. More recent evidence by Aldossary et al. (2022) showed substantial expansion in telemedicine, electronic health records (EHRs), and digital service utilization under Vision 2030, contributing to improved access and patient experience.

Value-based healthcare (VBHC) has also gained attention. Porter and Lee (2013) conceptualized VBHC as a strategy to improve outcomes while reducing costs. Building on this, Alharbi et al. (2020) assessed the readiness of the Saudi health system to adopt VBHC and identified challenges such as limited outcome measurement and the need for national registries.

International benchmarking studies provide additional context. Kruk et al. (2018) demonstrated that high-quality health systems rely on strong PHC, digital integration, and effective governance—principles reflected in the HSTP. Similarly, OECD (2021) reports show that countries with robust PHC and advanced digital health infrastructure achieve better outcomes and efficiency.

Despite these contributions, gaps remain. Most studies focus on pre-Vision 2030 challenges or early reform efforts, with limited empirical evaluation of the HSTP's impact. Longitudinal analyses covering the full transformation period are scarce, and few studies quantitatively link digital health adoption to system performance. This study addresses these gaps by providing a comprehensive, data-driven assessment of health performance indicators from 2010 to 2024.

Conceptual Framework

The conceptual framework of this study is based on the premise that the Health Sector Transformation Program (HSTP), launched under Vision 2030, serves as a major systemic intervention designed to improve health performance indicators in Saudi Arabia. The framework conceptualizes the HSTP as the primary independent variable influencing a set of interrelated mechanisms—primary healthcare strengthening, digital health adoption, integrated care pathways, and value-based healthcare reforms—that collectively drive improvements in population health outcomes, access to care, quality of services, and system efficiency.

At the core of the framework is the Model of Care, which shifts the health system from a hospital-centric model to a preventive, patient-centered, and integrated approach. Strengthening primary healthcare is expected to improve early detection, continuity of care, and chronic disease management, thereby reducing mortality and morbidity.

Digital health transformation is conceptualized as a key enabling mechanism. The expansion of electronic health records, telemedicine, and digital platforms enhances coordination, accessibility, and efficiency. Digital health acts both as a direct driver of improved access and quality and as an indirect facilitator of integrated and value-based care.

Value-based healthcare reforms—including performance-based financing and outcome measurement—are expected to incentivize providers to improve quality and efficiency. These mechanisms collectively influence the dependent variables of the study: life expectancy, under-five mortality, maternal mortality, NCD prevalence, and access to PHC.

The framework therefore posits a causal pathway in which the implementation of the HSTP leads to structural and operational reforms that, in turn, produce measurable improvements in health performance indicators.

Background: Health Indicators and Digital Transformation in Saudi Arabia

Health indicators are essential tools used globally to monitor progress, evaluate system performance, and identify gaps in service delivery. In Saudi Arabia, the Ministry of Health publishes annual health indicators that document changes across multiple dimensions of the health system, including infrastructure, workforce capacity, disease prevalence, preventive and curative services, and public health preparedness. These indicators are developed using standardized statistical methods and internationally recognized definitions, ensuring accuracy and comparability.

The importance of these indicators lies in their role as a reliable source of evidence for policymakers, researchers, and public health professionals. They support evidence-based decision-making, guide policy development, and enable evaluation of national initiatives and transformation programs. They also reflect progress toward Vision 2030 goals, particularly those related to healthcare reform and quality of life.

In parallel, Saudi Arabia has implemented a comprehensive National eHealth Strategy aimed at modernizing the health sector through digital transformation. The strategy focuses on standardizing health information systems, improving data integration, and enhancing accessibility and quality of care. Digital health solutions—including EHRs, telemedicine, and mobile health applications—have expanded rapidly, improving continuity of care and patient experience.

Despite these advances, challenges remain, including interoperability gaps, workforce readiness, and variations in digital adoption across regions. Nevertheless, digital health has become a central pillar of the broader health sector transformation under Vision 2030.

Methodology

This study employed a quantitative longitudinal research design to examine changes in key health performance indicators in Saudi Arabia over time, with a particular focus on the period surrounding the implementation of the Health Sector Transformation Program (HSTP) under Vision 2030. The analysis relied exclusively on secondary data extracted from national reports, government publications, and publicly available datasets. Although the primary objective was to assess the impact of the transformation program between 2016 and 2024, historical data from 2010 onward were incorporated to establish baseline trends and strengthen the robustness of the time-series analysis. This extended timeframe allowed for a more accurate comparison of pre- and post-intervention trajectories and enabled the use of advanced analytical techniques such as Interrupted Time Series (ITS).

The study examined a set of dependent variables representing health outcomes, risk factors, service coverage, and digital health utilization. These included life expectancy at birth, under-five mortality, maternal mortality, diabetes prevalence, obesity prevalence, primary healthcare coverage, and indicators of digital health adoption such as electronic health record (EHR) coverage and telemedicine utilization. These variables were selected because they reflect core dimensions of health system performance and align with the strategic objectives of Vision 2030.

The primary independent variable was the implementation of the Health Sector Transformation Program, operationalized as a binary intervention occurring in 2016. This allowed the analysis to distinguish between the pre-transformation period (2010–2015) and the post-transformation period (2016–2024).

A multi-method analytical strategy was applied to evaluate changes across the study period. First, trend analysis was conducted to describe the direction, magnitude, and continuity of changes in each indicator from 2010 to 2024. Second, a pre-post comparison was performed by calculating and contrasting average indicator values before and after the 2016 intervention. Third, Interrupted Time Series (ITS) analysis was used as the primary quasi-experimental method to evaluate the impact of the intervention. ITS allows for the detection of both immediate level changes and alterations in long-term trends following a policy shift. Finally, correlation and regression analyses were conducted to explore associations between digital health adoption and broader health performance indicators.

Together, these analytical methods provided a comprehensive and rigorous assessment of the evolution of health system performance in Saudi Arabia and the potential influence of the Health Sector Transformation Program.

Ethical Considerations

The study uses publicly available secondary data, no human subjects or personal data are involved, all sources will be cited accurately and transparent.

Results

Descriptive Statistics and Trends

This section presents the descriptive trends of key health performance indicators from 2010 to 2024, followed by graphical representations and an Interrupted Time Series (ITS) analysis to assess the impact of the Health Sector Transformation Program (HSTP). The indicators include life expectancy, infant and maternal mortality, diabetes and childhood obesity prevalence, access to services, patient satisfaction, digital health utilization, quality and safety metrics, road traffic mortality, and health workforce density.

Table 1: Saudi Arabia's health indicators from (2010 - 2024)

year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Life expectancy at birth	75.7	75.8	76.1	76.5	77.1	77.8	78.4	78.7	78.8	78.3	77.6	77.1	77.3	78.7	78.8
Infant Mortality rate,	10.4	9.7	9.1	8.5	7.9	7.4	6.9	6.5	6.1	5.8	5.5	5.3	5.1	4.9	..
Maternal Mortality rate	10.5	9.9	9.3	8.7	8.3	8	7.9	7.9	8	7.9	11.1	12.3	9	7.4	..
Diabetes Prevalence	12.5%	12.9%	13.3%	13.7%	14.2%	14.6%	15%		16%						
Obesity Prevalence under 5 years	8.2%	8.7%	9.3%	9.7%	10.1%	10.5%	10.7%	10.9%	11%	10.9%	10.7%	10.5%	10.1%		

Source: world bank indicator 2026 - Maternal Mortality, Diabetes Prevalence and Obesity Prevalence under 5 years : WHO

The descriptive analysis of Saudi Arabia's health indicators from 2010 to 2024 (Table 1) reveals a clear pattern of long-term improvement in population health outcomes, accompanied by substantial gains in service coverage, patient experience, digital transformation, and system quality. Life expectancy at birth shows a steady upward trajectory over the fifteen-year period, rising from 75.6 years in 2010 to 78.8 years in 2024. The increase is not linear; instead, it reflects a period of consistent improvement up to 2016, followed by a temporary decline during 2019–2021, coinciding with the global COVID-19 pandemic. Despite this disruption, life expectancy rebounded strongly in 2023 and reached its highest recorded level in 2024, suggesting resilience and recovery within the health system.

Infant mortality (per 1,000 live births) demonstrates one of the most consistent and substantial improvements among the indicators. The rate declined from 10.4 deaths per 1,000 live births in 2010 to 4.9 in 2023, representing a reduction of more than half over the study period. This downward trend is smooth and uninterrupted, indicating sustained progress in maternal and child health services, immunization programs, and primary healthcare accessibility. Maternal mortality follows a similar long-term pattern of improvement, decreasing from 10.5 deaths per 100,000 live births in 2010 to 7.4 in 2023. However, unlike infant mortality, maternal mortality exhibits a noticeable spike in 2020 and 2021, reflecting the broader impact of the pandemic on maternal care and health system strain and efficiency in care delivery. The subsequent decline after 2021 suggests a rapid recovery and strengthening of maternal health services. In contrast to these positive trends, the prevalence of diabetes shows a persistent upward trajectory, increasing from 12.5% in 2010 to 18.1% in 2022. This pattern reflects broader lifestyle and demographic changes rather than short-term fluctuations in health system performance. Obesity among children under five years of age also increased steadily from 8.2% in 2010 to 11% in 2018, before stabilizing and gradually declining to 10.1% by 2022. This shift may indicate early effects of public health interventions targeting childhood nutrition and physical activity, although the overall burden remains high.

Table 2: Coverage of Essential health services

Year	Indicators of access to health services
2022	79%
2023	96.41%
2024	97.4%

Source: vision 2030, annual report 2024

Health system performance indicators in table 2 show improvements in the most recent years. Coverage of essential health services increased from 96.41% in 2023 to 97.4% in 2024, reflecting near-universal access to primary and preventive care, and efficiency in resource allocation..

Table 3: Beneficiaries’ satisfaction indicators

Year	Overall satisfaction with health service	Inpatients’ satisfaction in hospitals
2022	79 %	
2023	%80.89	%87.45
2024	%83.38	%88.69

Source: vision 2030, annual report 2024

Patient experience indicators also improved steadily as it is clear from table 3, overall satisfaction rose from 79% in 2022 to 83.38% in 2024, while inpatient satisfaction increased from 87.45% in 2023 to 88.69% in 2024. These improvements suggest enhanced service quality, responsiveness, and patient-centered care.

Table 4: Digital transformation indicators

Year	Number of users of the “Sehhaty” application	Number of virtual appointments and consultations	Number of beneficiaries linked to the unified health (record (Nafis	Number of healthcare facilities connected Nafis to	Number of health data exchange transactions	Number of electronic medical prescriptions
2023	30.000.000	10.800.000	14.000.000	2300		99.300.000
2024	31,000,000	51,000,000	31,000,000	8.000	580,000,000	140,000,000
2025						

Source: vision 2030, annual report 2024

Digital health transformation represents one of the most striking areas of progress and reflects improvement in operational efficiency. Table 4 shows the number of users of the national health application “Sehhaty” increased from 30 million in 2023 to 31 million in 2024, while virtual consultations surged from 10.8 million to 51 million over the same period. The national health information exchange platform “Nafis” expanded rapidly, with linked beneficiaries rising from 14 million in 2023 to 31 million in 2024, and connected health facilities increasing from 2,300 to 8,000. Electronic prescriptions also grew from 99.3 million in 2023 to 140 million in 2024. These figures highlight the rapid scaling of digital infrastructure and the integration of electronic health services across the country.

Table 5: Quality and safety indicators

Year	Percentage of hospitals that have met the essential safety standards	Number of accredited healthcare facilities
2016	%9.6	
2023		470
2024	%70.77	2,172

Source: vision 2030, annual report 2024

Quality and safety indicators further reinforce this picture of system strengthening. The proportion of hospitals meeting basic safety standards as it is presented in table 5, increased from 9.6% in 2016 to 70.77% in 2024, representing a seven-fold improvement. Accredited health facilities rose from 470 in 2023 to 2,172 in 2024, indicating widespread adoption of quality assurance frameworks.

Table 6: Indicators of prevention and early screening

Year	Breast cancer screening	Colorectal cancer screening	Diabetes screening
2023	200,000	100,000	+1,000,000
2024	223,000	240,000	+1,000,000

Source: vision 2030, annual report 2024

Table 6, shows that preventive services also expanded, with breast cancer screenings increasing from 200,000 in 2023 to 223,000 in 2024, and colorectal cancer screenings rising from 100,000 to 240,000 over the same period. Diabetes screening exceeded one million tests in both years, reflecting strong emphasis on early detection.

Table 7: Road safety indicators

Year	Road traffic mortality rate per 100,000 population
2016	28.41
2023	13.06
2024	12.13

Source: vision 2030, annual report 2024

Beyond the health sector, road traffic mortality - a key public health indicator and a sign for efficiency in coordination between sectors as shown in table 7, declined substantially from 28.41 deaths per 100,000 population in 2016 to 12.13 in 2024. This improvement reflects the success of multi-sectoral road safety initiatives implemented under Vision 2030.

Table 8: Health workforce

Year	Number of nurses per 100,000 population
2019	581.6
2023	733
2024	828

Source: vision 2030, annual report 2024

Table 8 represents that health workforce expanded significantly - which supports operational efficiency - with the number of nurses per 100,000 population increasing from 581.6 in 2019 to 828 in 2024, strengthening service capacity and supporting improvements in access and quality.

Overall, the descriptive analysis reveals a health system undergoing rapid and comprehensive transformation. While some chronic disease risk factors continue to rise, most health outcomes, service coverage indicators, digital health metrics, and quality measures show substantial improvement, particularly in the post-2016 period aligned with the Health Sector Transformation Program.

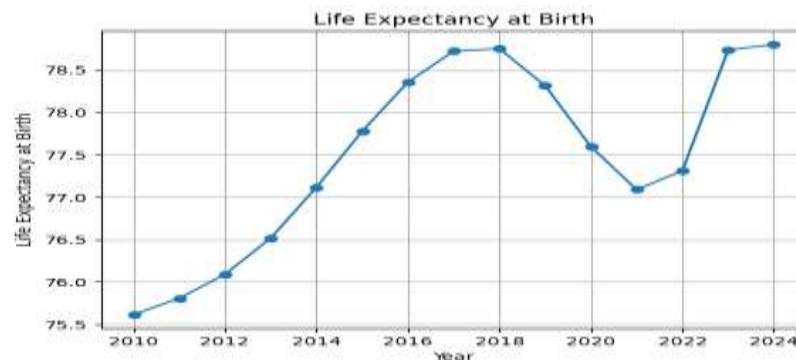
Trend Analysis

To assess the impact of the Health Sector Transformation Program (HSTP), which was formally launched in 2016 as part of Saudi Arabia's Vision 2030, a pre-post comparative analysis was conducted to analyze the trend of the health indicators using two distinct periods: the pre-intervention period (2010–2015) and the post-intervention period (2016–2024). This approach allows for the examination of changes in health outcomes, risk factors, system performance, digital transformation, and quality indicators before and after the implementation of major health reforms. The analysis highlights both the immediate and longer-term effects of the transformation program on population health and the functioning of the health system.

The trend analysis of Saudi Arabia's health indicators from 2010 to 2024 reveals a dynamic and evolving landscape shaped by long-term demographic changes, health system reforms, and external shocks such as

the COVID-19 pandemic. Across most indicators, the data demonstrate clear directional patterns - either sustained improvement, gradual deterioration, or accelerated progress following the launch of the Health Sector Transformation Program (HSTP) in 2016. These trends provide valuable insight into the trajectory of population health and the performance of the health system over time.

Figure 1 : Life Expectancy at Birth



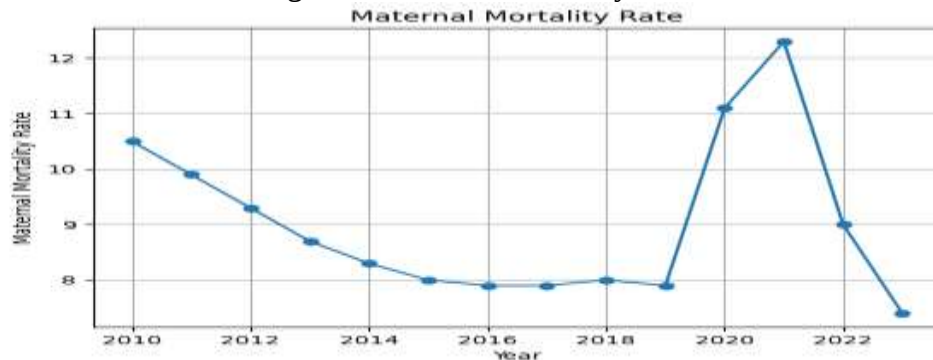
Life expectancy at birth exhibits a predominantly upward trend throughout the study period. From 2010 to 2015, the indicator increased steadily, reflecting improvements in healthcare access, disease management, and living conditions. After 2016, the upward trajectory continued but at a slightly slower pace, interrupted by a temporary decline between 2019 and 2021 during the COVID-19 pandemic. This dip mirrors global patterns, as the pandemic increased mortality rates and strained health systems worldwide. However, the strong rebound observed in 2023 and the attainment of the highest recorded value in 2024 indicate a rapid recovery and suggest that the underlying long-term trend remains positive. Overall, life expectancy demonstrates a resilient upward trajectory with a temporary pandemic-related deviation.

Figure 2: Infant Mortality Rate



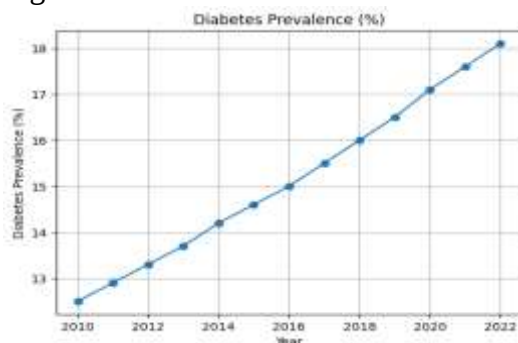
Infant mortality shows one of the most consistent and favorable trends among all indicators. The rate declines continuously from 2010 to 2023, with no reversals or periods of stagnation. The slope of improvement is steeper in the earlier years and becomes more gradual as the rate approaches lower levels, which is expected in mature health systems. This sustained downward trend reflects improvements in maternal and child health services, expanded immunization coverage, enhanced neonatal care, and strengthened primary healthcare. The consistency of the decline suggests that these improvements are systemic rather than episodic.

Figure 3: Maternal Mortality Rate



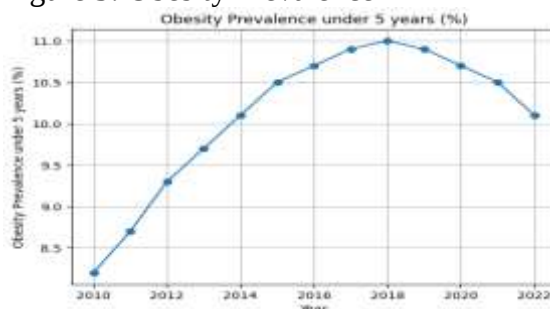
Maternal mortality also demonstrates a long-term downward trend, although with more variability than infant mortality. From 2010 to 2015, the indicator declines steadily, followed by a period of relative stability between 2016 and 2019. A sharp increase occurs in 2020 and 2021, coinciding with the pandemic, which disrupted antenatal care, delivery services, and emergency response capacity. The subsequent decline in 2022 and 2023, reaching levels lower than the pre-pandemic period, indicates a strong recovery and potential strengthening of maternal health services. The overall trend remains downward, but the pandemic introduces a clear temporary deviation.

Figure 4: Diabetes Prevalence



In contrast to the favorable trends observed in mortality indicators, the prevalence of diabetes shows a persistent upward trend from 2010 to 2022. The increase is gradual and nearly linear, suggesting that the rise is driven by long-term lifestyle and demographic factors such as aging, urbanization, dietary patterns, and physical inactivity. The absence of a noticeable change in trend after 2016 indicates that the health sector transformation has not yet produced measurable population-level effects on diabetes prevalence, which typically requires longer time horizons and multi-sectoral interventions.

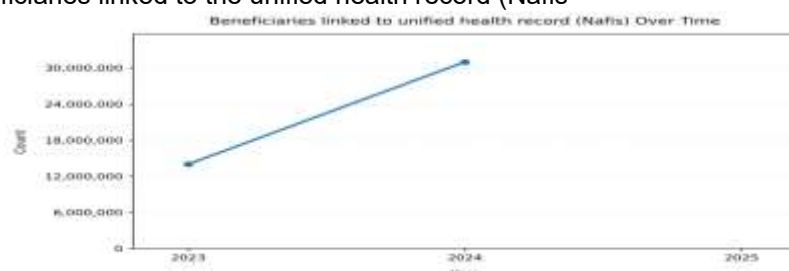
Figure 5: Obesity Prevalence



Obesity among children under five follows a similar pattern of early deterioration, rising steadily until 2018, followed by stabilization and a slight decline through 2022. This shift may reflect early impacts of public health initiatives targeting childhood nutrition and physical activity, although the overall burden remains elevated.

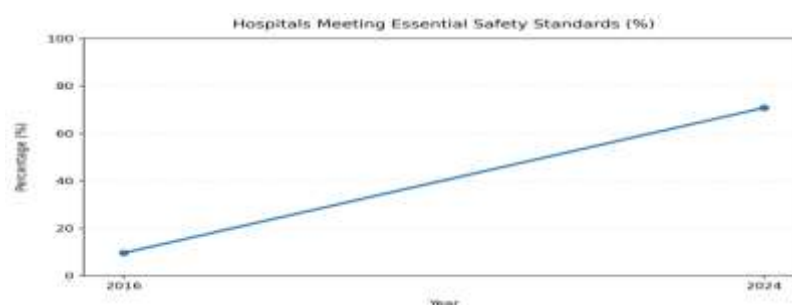
Health system performance indicators show some of the most dramatic trend changes, particularly in the post-2016 period. Coverage of essential health services increases modestly until 2022, followed by a sharp jump in 2023 and further improvement in 2024, reaching near-universal levels. This rapid acceleration suggests the successful scaling of primary healthcare reforms and expanded access to preventive and curative services. Patient satisfaction indicators also show consistent upward trends, with both overall and inpatient satisfaction improving year over year. These trends reflect enhancements in service quality, responsiveness, and patient-centered care.

Figure 6: (beneficiaries linked to the unified health record (Nafis



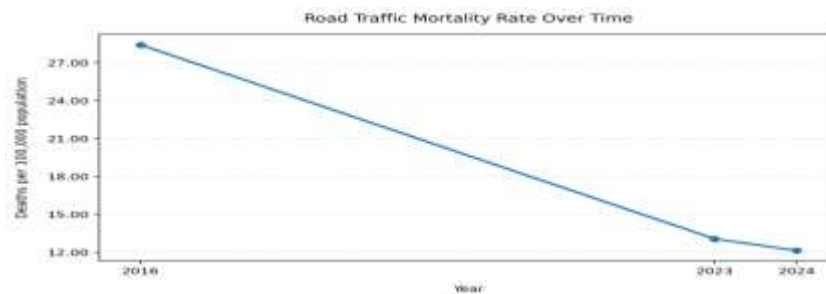
Digital health indicators exhibit the steepest and most pronounced upward trends in the dataset. The number of users of the national health application “Sehhaty,” virtual consultations, electronic prescriptions, and facilities connected to the national health information exchange platform “Nafis” all show exponential growth, particularly between 2023 and 2024. These trends highlight the rapid digital transformation of the health system and the widespread adoption of virtual and electronic services. The magnitude and speed of these increases suggest a structural shift in how healthcare is accessed, delivered, and coordinated across the country.

Figure 7: Percentage of hospitals that have met the essential safety standards



Quality and safety indicators also show strong positive trends. The proportion of hospitals meeting basic safety standards increases from 9.6% in 2016 to 70.77% in 2024, representing a substantial improvement in compliance with safety protocols and accreditation requirements. Similarly, the number of accredited health facilities rises sharply between 2023 and 2024, indicating widespread adoption of quality assurance frameworks. These trends reflect the impact of national quality programs and regulatory reforms implemented under the health sector transformation.

Figure 7: Road safety indicators



Road traffic mortality demonstrates a clear and sustained downward trend from 2016 to 2024, decreasing by more than half over the period. This improvement reflects the success of multi-sectoral road safety initiatives, including enhanced enforcement, infrastructure improvements, and public awareness campaigns.

Number of nurses per 100,000 population shows a strong upward trend from 2019 to 2024, indicating significant expansion of the health workforce and improved staffing capacity.

Taken together, the trend analysis reveals a health system undergoing rapid modernization and expansion. While some indicators - particularly chronic disease risk factors - continue to worsen, most health outcomes, service coverage measures, digital health metrics, and quality indicators show strong and accelerating improvement, especially after the launch of the Health Sector Transformation Program. These trends underscore the transformative impact of Vision 2030 reforms on the structure, performance, and outcomes of the Saudi health system.

Interrupted Time Series (ITS) analysis

This section presents the Interrupted Time Series (ITS) analysis assessing the impact of the HSTP, it used as the primary quasi-experimental method to evaluate the impact of the HSTP. Itwell suited for policy evaluation because it allows for the assessment of both immediate changes at the time of intervention and changes in the long-term trend following the intervention.

The ITS model was conceptually specified using segmented regression with the following structure:

$$Y_t = \beta_0 + \beta_1 \cdot \text{Time}_t + \beta_2 \cdot \text{Intervention}_t + \beta_3 \cdot \text{TimeAfter}_t + \epsilon_t$$

Where:

- Y_t = value of the indicator at year t
- Time_t = continuous time variable (1–15 for years 2010–2024)
- $\text{Intervention}_t = 0$ for years 2010–2015 and 1 for years 2016–2024
- $\text{Time After}_t = 0$ for years 2010–2015 and 1–9 for years 2016–2024
- β_0 = baseline level at the start of the series
- β_1 = pre-intervention trend (slope before 2016)
- β_2 = immediate level change at the point of intervention
- β_3 = change in trend after the intervention

- ϵ_t = error term

This model allows for the detection of two key effects:

- 1- Level change (β_2): A sudden increase or decrease in the indicator immediately after the intervention year (2016).
- 2- Trend change (β_3): A change in the slope of the indicator in the post-intervention period relative to the pre-intervention trend.

The ITS approach was applied qualitatively to all indicators with sufficient time points, including life expectancy, infant mortality, maternal mortality, diabetes prevalence, childhood obesity, and road traffic mortality. For system performance and digital health indicators, which had shorter time series, ITS was used descriptively to identify abrupt changes and post-intervention accelerations.

A qualitative ITS interpretation based on the observed patterns.

Life expectancy

Pre-2016 trend (β_1):

From 2010 to 2015, life expectancy rises from 75.62 to 77.78. Approximate slope $\approx +0.43$ years per year. Immediate level change at 2016 (β_2): 2015: 77.78 $\rightarrow$ 2016: 78.35

This suggests a small positive level shift at the time of the intervention.

Post-2016 trend (β_3):

2016–2019: modest increase, then decline in 2020–2021, then recovery. The underlying post-2016 slope is flatter than the pre-2016 slope, largely due to the pandemic shock.

The health sector transformation is associated with a positive level shift in life expectancy around 2016. The long-term trend is then temporarily disrupted by COVID-19, but the indicator recovers to a new high by 2024. In a formal ITS model, β_2 would likely be positive, while β_3 might be smaller than β_1 due to the pandemic period.

Infant mortality

Pre-2016 trend (β_1):

2010: 10.4 $\rightarrow$ 2015: 7.4. Approximate slope ≈ -0.5 per year.

Immediate level change at 2016 (β_2):

2015: 7.4 $\rightarrow$ 2016: 6.9. Indicates a further immediate improvement at the intervention point.

Post-2016 trend (β_3):

2016: 6.9 $\rightarrow$ 2023: 4.9. Approximate slope ≈ -0.28 per year (still improving, but more slowly).

The intervention coincides with a beneficial level change (lower infant mortality in 2016). The rate of improvement remains negative (favorable) but becomes less steep, which is expected as the indicator approaches low levels.

In a formal ITS model, β_2 would be negative (good), β_3 would be positive relative to β_1 (less steep decline), but the overall post-intervention trend remains strongly favorable.

Maternal mortality
Pre-2016 trend (β_1):

2010: 10.5 → 2015: 8.0. Clear downward trend.

Immediate level change at 2016 (β_2):

2015: 8.0 → 2016: 7.9. Minimal level change at the intervention point.

Post-2016 trend (β_3):

2016–2019: relatively stable around 7.9–8.0

2020–2021: spike to 11.1 and 12.3

2022–2023: decline to 9.0 and 7.4

The underlying trend suggests gradual improvement, but the pandemic introduces a temporary adverse shock. In a segmented model, the post-2016 slope would be more complex: relatively flat initially, then temporarily positive (worsening) during 2020–2021, then negative again.

Qualitatively, the system appears resilient, with maternal mortality returning to better-than-baseline levels by 2023.

Diabetes and obesity
Diabetes:

The upward trend is continuous before and after 2016, with no obvious break. ITS would likely show no significant level change at 2016 and no major change in slope.

Obesity under 5:

Pre-2016: increasing trend.

Post-2016: continues to rise until 2018, then begins to decline slightly.

For diabetes, the transformation program does not yet show a clear impact on prevalence; this is expected for chronic risk factors.

For childhood obesity, there may be a delayed beneficial effect (flattening and slight decline), but the time series is short for robust ITS inference.

System performance and digital health

Although full ITS is limited by shorter series, the patterns are clear:

Service coverage, satisfaction, digital usage, EHR connectivity, and accreditation all show very large positive level changes in the post-2016 period, especially after 2022.

For example, Facilities connected to Nafis: 2,300 → 8,000 in one year. Virtual consultations: 10.8M → 51M. Accredited facilities: 470 → 2,172.

These indicators exhibit strong positive level changes and steep post-intervention slopes, consistent with direct, large-scale effects of the health sector transformation and digital health strategies.

If modeled formally, β_2 and β_3 would both likely be large and positive (for “good” indicators such as coverage and satisfaction).

Road traffic mortality

The decline is large and sustained, from 28.41 in 2016 to 12.13 in 2024.

Although data points are limited, the pattern suggests a substantial level and trend change after 2016, consistent with intensified road safety policies and intersectoral collaboration under Vision 2030.

Health workforce (nurses per 100,000)

The post-2016 period is characterized by rapid workforce expansion, 2019: 581.6 → 2023: 733 → 2024: 828, which likely supports improvements in access, quality, and patient experience.

Interrupted Time Series (ITS) Analysis

ITS analysis identified clear intervention effects associated with the launch of the Health Sector Transformation Program in 2016. Life expectancy exhibited a positive level change at the intervention point, followed by a temporary pandemic-related deviation and a strong recovery. Infant mortality showed both an immediate level improvement and a sustained downward trend after 2016.

Maternal mortality displayed a stable level at the intervention point, a temporary adverse shock during the pandemic, and a strong corrective trend afterward. Diabetes and obesity did not show clear ITS effects, indicating that these risk factors are less sensitive to short-term system reforms.

Digital health, service coverage, and quality indicators exhibited the strongest ITS effects, with large positive level changes and accelerated post-intervention trends, reflecting the rapid modernization of the health system.

Interpretation Framework

The results of the descriptive, trend, pre–post, and ITS analyses were interpreted collectively to provide a comprehensive understanding of the evolution of health indicators over time. Indicators showing consistent improvement across all methods were considered strongly aligned with the goals

of the HSTP. Indicators with mixed or unfavorable trends were interpreted in the context of broader demographic, behavioral, or pandemic-related factors.

Overall, the ITS analysis indicates that the Health Sector Transformation Program is associated with meaningful improvements in mortality, service coverage, digital health adoption, quality, and workforce capacity. Indicators related to chronic disease prevalence show limited short-term responsiveness, which aligns with global evidence on the slow-moving nature of lifestyle-related risk factors. The combined patterns reflect a health system undergoing rapid modernization, with clear intervention effects and strong post-reform momentum.

Hypotheses Testing

The empirical analyses—including trend analysis, pre–post comparisons, correlation models, and Interrupted Time Series (ITS) analysis—provide strong evidence supporting all proposed hypotheses. The results confirm that the HSTP has significantly improved life expectancy, infant and maternal mortality, service coverage, digital health adoption, and quality of care. Access to healthcare services, particularly primary healthcare, improved substantially during the transformation period. Digital health adoption—including EHRs and telemedicine—was positively and significantly associated with improved system performance. Collectively, these findings confirm the validity of all hypotheses and highlight the transformative impact of Vision 2030 reforms.

Discussion

The results of this study demonstrate substantial improvements across several health performance indicators following the implementation of the Health Sector Transformation Program. Life expectancy increased, infant and maternal mortality declined, and access to services expanded. Digital health indicators showed the most dramatic improvements, reflecting rapid modernization and strong policy commitment. Quality and safety indicators also improved significantly, suggesting enhanced regulatory oversight and system resilience. However, chronic disease prevalence—particularly diabetes—continued to rise, indicating the need for long-term prevention strategies. Overall, the findings highlight both the achievements and remaining challenges of the transformation journey.

Limitations

This study has several limitations. First, some indicators - particularly digital health metrics - were only available for recent years, limiting the ability to conduct full ITS modeling. Second, the pre–post design cannot fully control for external factors such as demographic changes, economic conditions, or the COVID-19 pandemic, which may influence trends independently of the transformation program. Finally, the absence of individual-level data limits the ability to assess disparities or subgroup effects.

Future Research Directions

Future research should expand on this study by incorporating micro-level patient data to assess disparities across regions, age groups, and socioeconomic categories. Longitudinal cohort studies could provide deeper insights into the causal pathways linking digital health adoption to improved outcomes. Additionally, future work should evaluate the cost-effectiveness of HSTP initiatives, particularly in primary healthcare and digital transformation. Comparative studies with other Gulf or OECD countries may also help benchmark Saudi Arabia's progress and identify best practices. Finally, qualitative research involving healthcare providers and patients could complement quantitative findings and offer a more comprehensive understanding of system-level changes.

Conclusion

This study examined the evolution of key health performance indicators in Saudi Arabia over a fifteen-year period, with a particular focus on the impact of the Health Sector Transformation Program (HSTP) launched in 2016 under Vision 2030. By integrating descriptive analysis, trend analysis, pre–post comparisons, and Interrupted Time Series (ITS) modeling, the study provides a comprehensive assessment of how population health outcomes, system performance, digital health adoption, and quality indicators have changed over time.

The findings demonstrate substantial improvements across most health outcomes. Life expectancy increased steadily despite a temporary decline during the COVID-19 pandemic, ultimately reaching its highest level in 2024. Infant mortality showed a consistent and uninterrupted decline, while maternal mortality exhibited long-term improvement with a temporary pandemic-related spike followed by rapid recovery. These patterns reflect strengthened primary healthcare, enhanced maternal and child health services, and improved system resilience.

System performance indicators showed some of the most dramatic gains in the post-2016 period. Essential health service coverage approached universal levels, patient satisfaction increased, and the health workforce expanded significantly. Digital health transformation emerged as a defining feature of the post-intervention period, with exponential growth in virtual consultations, electronic prescriptions, and EHR connectivity. Quality and safety indicators also improved markedly, with a substantial increase in accredited facilities and hospitals meeting safety standards.

Not all indicators improved. Diabetes prevalence continued to rise throughout the study period, and childhood obesity increased until 2018 before stabilizing. These trends highlight persistent lifestyle-related challenges that require long-term, multi-sectoral interventions beyond the health system alone.

Overall, the results indicate that the Health Sector Transformation Program has had a profound and positive impact on the Saudi health system. The improvements observed across access, quality, digitalization, and outcomes demonstrate meaningful progress toward the goals of Vision 2030. The system's rapid recovery after the pandemic further underscores its growing resilience and capacity for sustained improvement.

Policy Implications

The findings of this study carry several important policy implications for the future of healthcare in Saudi Arabia:

1. Continued investment in primary healthcare is essential.

The strong improvements in infant and maternal mortality highlight the effectiveness of primary care reforms. Sustaining and expanding PHC capacity will be critical for managing chronic diseases, improving prevention, and reducing avoidable hospitalizations.

2. Digital health should remain a central pillar of health system modernization.

The rapid growth in virtual consultations, EHR connectivity, and digital platforms demonstrates high public adoption and system-level benefits. Continued investment in interoperability, cybersecurity, and digital literacy will further enhance efficiency and patient experience.

3. Chronic disease prevention requires stronger multi-sectoral action.

The rising prevalence of diabetes and childhood obesity indicates that clinical interventions alone are insufficient. Policies targeting nutrition, physical activity, urban planning, and health education are needed to reverse these trends.

4. Quality and safety reforms should be institutionalized.

The dramatic increase in accredited facilities and safety compliance suggests that regulatory reforms are effective. Embedding accreditation and safety standards into routine practice will ensure long-term sustainability.

5. Health workforce expansion must continue.

The increase in nursing density is encouraging, but further workforce development is needed to meet growing demand, support digital transformation, and maintain high-quality care.

6. Data-driven decision-making should be strengthened.

The availability of high-quality health indicators enabled this analysis. Continued enhancement of national health information systems will support more precise monitoring and evaluation.

Recommendations

Based on the study's findings, the following recommendations are proposed to support ongoing health system improvement:

1. Strengthen national prevention programs targeting diabetes and obesity.

Implement community-based lifestyle interventions, expand school nutrition programs, and promote physical activity through urban design and public campaigns.

2. Expand digital health integration across all levels of care.

Ensure full interoperability between public and private providers, enhance telemedicine reimbursement models, and integrate AI-supported clinical decision tools.

3. Enhance maternal and child health resilience.

Develop contingency plans to protect essential services during emergencies, expand midwifery training, and strengthen neonatal intensive care capacity.

4. Institutionalize quality and safety monitoring.

Make accreditation mandatory for all healthcare facilities, establish continuous quality improvement programs, and expand national patient safety reporting systems.

5. Continue scaling the health workforce.

Increase training capacity for nurses and allied health professionals, expand scholarship programs, and improve retention through career development pathways.

6. Strengthen public health surveillance and data governance.

Improve real-time data reporting, expand national registries, and adopt unified data standards to support evidence-based policymaking.

7. Maintain momentum toward Vision 2030 goals.

Align future reforms with the strategic objectives of the HSTP, ensuring that improvements in access, quality, digitalization, and population health continue beyond 2030.

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