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Quantitative Indicators as Exploratory Signals in Health System Transformation: A Cautious Assessment of Service Performance under Saudi Arabia's SHSTP

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Abstract: The Saudi Health Sector Transformation Program (SHSTP) is a central pillar of Vision 2030. It has accelerated the transition toward data-driven performance monitoring in hospitals nationwide. The healthcare system is currently undergoing significant reforms and massive digital expansion. This study draws on routine hospital dashboard data collected between 2019 and 2023, covering a regional, case-based exploratory sample of four hospitals two clustered and two non-clustered across the Mecca and Al-Sharqiyyah regions. We use collected indicators to track service availability and patient-centered progress. However, the administrative nature of the data and inconsistent datasets require careful interpretation. **Objective** This study aims to present a cautious, descriptive assessment of quantitative performance indicators, treating these as exploratory signals to support the ongoing evaluation of the SHSTP, rather than as definitive measures of programme performance or policy impact. **Methods** We examined routine hospital dashboard data from 2019 to 2023. The study covered both clustered and non-clustered facilities. Key indicators included patient satisfaction, wait times, bed occupancy, and readmission ratios. We also analysed digital metrics such as telemedicine application, Electronic Medical Record (EMR) documentation, and online appointment scheduling. We used descriptive summaries and periodic visualizations to identify patterns without applying inferential analysis. We noted data gaps, essential modifications, and administrative artifacts to reflect the limitations of routine information systems. **Results** Patient satisfaction scores displayed a broadly upward directional pattern across all four hospitals, with periodic fluctuations reflecting operational transitions and reporting variability. Outpatient and emergency wait-time indicators showed mild downward patterns. Digital health indicators specifically telemedicine encounters, EMR usage, and online appointments showed strong upward signals. Clustered hospitals demonstrated more consistent directional patterns compared to non-clustered facilities. However, readmission ratios and bed-occupancy rates remained variable and showed no clear directional improvement, highlighting areas of persistent uncertainty in the data. Regional variations indicated different stages of implementation maturity. **Conclusions** Our findings reflect positive but inconsistent directional signals in SHSTP service performance. These signals should not be interpreted as evidence of causal performance improvement; they represent preliminary, context-specific observations from a small regional exploratory sample that cannot be generalised to the national healthcare system. The results highlight a critical need for stronger data governance, standardized indicator definitions, and continued investment in digital capacity. These elements will play a pivotal role in building a robust national reform monitoring system.

Key Words: Health System Transformation, Health Services Performance, Routine Health Information Systems, Digital Health Adoption, Patient-Centred Care, Saudi Arabia, Vision 2030

INTRODUCTION

Countries around the world are prioritising the transformation of their healthcare systems. While Saudi Arabia has articulated this goal through Vision 2030, a comprehensive national plan aimed at enhancing population health, improving service delivery, optimising resource use, and integrating advanced technology across the health sector. The Saudi Health Sector Transformation Program (SHSTP), initiated in 2016 emerged as a central component of this initiative, restructuring service delivery into smaller

geographical clusters to strengthen coordination and accountability [1]. The SHSTP reforms focuses on prioritising patient-centered care system, enhancing the use of digital health tools and maximising the workforce efficiency. Given the scale of this transformation, systematic performance monitoring is essential [2]. As Vision 2030 states: “We will improve quality and efficiency of health services enhancing focus on preventive care. Underscoring the need for measurable indicators to track progress toward transformation" (Vision 2030).

Examining health care services on a larger scale requires quantitative indicators that provide a clearer picture of how the healthcare system is performing, covering patient experience, use of digital tools, and operational efficiency [3]. Reliable administrative data plays a vital role in tracking progress of country's reform. Key indicators include such as patient satisfaction, occupancy, EMR, telemedicine use, and operational metrics [4]. Health system performance assessment frameworks including those developed within the international evaluation literature emphasise the importance of distinguishing between indicators designed for internal accountability and those suitable for evaluative research. Scholars working on indicator bias, measurement distortion, and the limits of administrative data have consistently argued that routine indicators must be interpreted with methodological caution, particularly during periods of major structural reform when definitions are unstable and data completeness is uneven [7,9,11]. Evidence from integrated governance models suggests that cluster-based arrangements can support improved coordination and patient engagement in health systems undergoing transformation [6].

Performance monitoring is a crucial aspect in the implementation of SHSTP. However, in the early stages of reform quantitative indicators faced notable challenges, a pattern commonly observed in emerging healthcare systems. These challenges were in fragmented time series, irregular definitions, and inconsistent reporting [7]. Indicators meant to design for internal management may not seem to meet the criteria. That can provide robust statistical references for digital transitions. Including EMRs and telemedicine documentation inconsistencies [8]. Global research indicates, administrative and routine datasets can facilitate policy learning, but require careful interpretation during periods of structural change [9].

A common problem in reform evaluation is that studies treat routine indicators as proof of policy success, despite relying on inconsistent or incomplete data. The global literature emphasises that evaluations drawing on indicators that lack clear methodological grounding and that do not account for contextual constraints risk producing misleading conclusions [10]. Overlooking these limitations can lead to hasty interpretations, create inequalities among regions and institutions, and cause policymakers to miss important warning signals that should prompt corrective action [11].

This paper follows conservative and pragmatic approach to interpret indicators during the implementation. It views routine metrics as means of exploring direction, variation among hospital types. And areas where reforms may be uneven. This stance reflects a genuine concern within the health systems research. For ethical interpretation of imperfect data and methodological constraints [12].

This paper has two primary aims. First, it presents a descriptive assessment of digital healthcare utilisation and operational performance in clustered and non-clustered hospitals in the Mecca and Al-Sharqiyyah regions between 2019 and 2023, with the findings interpreted as preliminary and exploratory. Second, it advances an evaluative stance that prioritises methodological integrity, contextual awareness, and transparency in the use of routine quantitative data. Rather than treating administrative indicators as definitive measures of performance or policy success, the study interprets them as exploratory signals that can highlight broad patterns, variation across organisational settings, and areas of uneven implementation under the Saudi Health Sector Transformation Program (SHSTP). By focusing on descriptive trends in patient experience, service efficiency, occupancy, and digital health use, the paper demonstrates how routine hospital dashboards when analysed cautiously can support policy learning without overstating causal claims during periods of rapid health system change.

Conceptual Framing

Routine Health Information Systems: Routine Health Information Systems (RHIS) are widely used to support operational management and performance monitoring through the continuous collection of administrative healthcare data. Unlike research datasets, RHIS are primarily designed for managerial and accountability purposes, which means that indicators often evolve and may vary in completeness and definition. During periods of large-scale health system reform, such as organisational restructuring or digital transformation, routine indicators are particularly susceptible to transitional artefacts and reporting inconsistencies. For this reason, the health systems literature emphasises cautious, transparent interpretation of RHIS data, treating observed patterns as exploratory or directional rather than definitive measures of performance or impact. In the Saudi context, hospital dashboards introduced under the Health Sector Transformation Program reflect these characteristics, providing useful but imperfect signals of system change that require contextualised analysis.

METHODS

Understanding the Saudi Health Sector Transformation Program (SHSTP) through quantitative indicators requires transparency about the data's origins, quality, and analytical limitations. This section describes the data's origins, features, ethical aspects, and the analytical approach used. The aim is to be explicit about the dataset's strengths and weaknesses and to clarify why these indicators are treated as preliminary signals, not conclusive results.

Table 1: Distribution of Clustered and Non-Clustered Hospitals Included in the Study Sample

Region	Total Hospitals Analysed	Clustered Hospitals	Non-Clustered Hospitals	Role in SHSTP
Mecca	2	1	1	Early implementation/pilot region
Al-Sharqiyyah (Eastern Province)	2	1	1	Phased rollout region
Total	4	2	2	Regional, case-based exploratory sample not nationally representative

Overview of the Saudi Health Sector Transformation Program (SHSTP)

The SHSTP began in 2016 as a key part of Saudi Arabia's Vision 2030. Its goal is to restructure the national healthcare system. The program aims to improve quality, efficiency, access, and the patient experience. Building on earlier reforms, the SHSTP moved away from a centrally managed model and introduced geographically defined health clusters, which integrate primary, secondary, and tertiary services under a single governance structure.

The SHSTP implemented in phases. Initial stages focused on policy, restructuring, and creating governance frameworks, including the rollout of cluster-based service models and digital health systems. Later phases emphasized expanding electronic medical records, telemedicine, and online appointment platforms. These tools support operational management and strategic decisions. Official reports show that while digital adoption has grown. The pace of implementation varies by region and hospital.

This uneven rollout has increased the availability of quantitative data. However, challenges with data completeness and standardization remain. As a result, dashboards are used to monitor reform progress, but there is little guidance on interpreting the data during this large-scale transformation. This study addresses that gap. We examine hospital indicators as exploratory signals, not as definitive performance measures. This provides a careful assessment of service patterns during the ongoing SHSTP implementation.

National Scope and Adoption of the SHSTP

Saudi Arabia has a large healthcare system with hundreds of public hospitals across many regions. The SHSTP is a national reform initiative. Its cluster-based governance has introduced progress across regions over time. Early implementation focused on select areas like Mecca and Al-Sharqiyyah. These served as pilot sites for testing the new cluster arrangements and digital systems.

As the program expanded, other regions adopted the cluster model at different stages. This variation was due to differences in readiness, infrastructure, and workforce. During study period, Saudi hospitals were at different points in the SHSTP implementation. Some operated within established clusters, while others remained under traditional governance. This phased rollout is the basis for the comparative study design. It is important to state clearly that this study examines clustered and non-clustered hospitals in two regions as a regional, case-based exploratory sample only. The findings cannot be treated as a representative picture of the Saudi healthcare system as a whole. Table 1 summarizes the distribution of hospitals included in our sample.

Data Origin

The unit of analysis in this study is the individual hospital facility. All indicators examined are facility-level aggregated measures drawn from administrative dashboards. This study does not analyse patient-level data, and findings should not be interpreted as measures of individual patient outcomes. The study utilises quantitative data from performance dashboards collected between 2019 and 2023, from both clustered and non-clustered facilities. These dashboards are administrative tools providing insights for managerial decision-making and operational planning, drawing from electronic medical records, patient experience portals, digital health applications, operational systems, and HR development platforms.

Dashboard data were compiled by hospital administrative and information technology teams as part of routine institutional reporting cycles. The research team accessed pre-aggregated datasets directly from institutional reporting portals. Completeness checks were conducted at the indicator level; reporting periods with substantial missing data were identified and flagged, and such periods were excluded from visual trend analyses. Missing data instances were logged descriptively rather than imputed, consistent with the exploratory and transparent analytical approach adopted throughout. The dashboards included several performance categories relevant to SHSTP priorities: Patient experience: monthly patient satisfaction scores, feedback categories, and service experience indicators. Service efficiency: outpatient and emergency wait times, bed occupancy percentages, and 30-day readmission metrics. Quality of care: chronic disease management indicators and adherence to established pathways. Digital transformation: utilisation of telemedicine, EMR documentation completeness, digital appointment scheduling, and virtual follow-ups. Workforce development: staff training hours, digital competency assessments, and workload distribution measures.

The selected metrics reflect core SHSTP domains, including patient-centred care, service efficiency, and digital transformation. While designed for managerial supervision, these indicators represent the most consistently available quantitative measures of hospital performance accessible during the transformation period. service efficiency, and digital transformation. They also reinforce accountability within the cluster model. While designed for managerial supervision. These indicators offer most reliable quantitative measures of hospital performance during the transformation.

Data Limitations

Using operational dashboards for evaluative research requires acknowledging several constraints. These are well-documented in routine health information system (RHIS) literature.

Table 2: Indicators and Data Sources

Indicator	Dashboard Source	Years	Known Limitations	Treatment in Analysis
Patient Satisfaction	Patient Experience Dashboard	2019–2023	Missing months; sampling differences	Used as monthly patterns
Telemedicine Encounters	Digital Health Dashboard	2019–2023	Definition shifts during digital upgrades	Treated as noisy upward trend
EMR Documentation Completeness	EMR System Report	2019–2023	Early under documentation	Used as digital maturity signal
Wait Times	Operations Dashboard	2019–2023	Manual entry delays	Directional only
Bed Occupancy	Capacity Dashboard	2019–2023	Different formulas	Within-hospital comparison only
Readmission Ratio	Quality Dashboard	2019–2023	Non-standard definitions; known definitional change during the study period limits comparability across years	Descriptive only
Staff Training Hours	HR Development Dashboard	2019–2023	Missing records	General pattern only

First, data availability varied among hospitals. Some facilities implemented dashboards earlier than others. This created reporting gaps from 2019 to 2021. Patient satisfaction and wait-time indicators were among the most affected by these early gaps, while digital health indicators such as EMR documentation completeness showed more consistent data availability from 2021 onwards. This pattern is common in transitioning health systems.

Second, standardized indicators were lacking in the initial years. Metrics for re-admission and training hours differed between facilities until national integration occurred. In RHIS research, this known as a comparability bias.

Third, these dashboards based on administrative reporting and can be bias. Hospitals might prefer indicators that align with their managerial KPIs. Others with less knowledge might rely on manual data entry. Similar trends seen in other low- and middle-income countries. Using administrative data to assess health services.

Fourth, rapid digital transitions in EMRs and telemedicine created inconsistencies. Initial data may reflect adoption rates rather than performance improvements. The readmission ratio indicator was particularly susceptible to definitional instability, with the metric definition changing at least once during the study period, which substantially limits the comparability of this indicator across years.

These limitations do not negate the value of the dashboards. Instead, they highlight the need for careful and transparent interpretation. A summary of known definitional changes by indicator and approximate timing is provided in the Supplementary Materials (Table S2), to support contextualised reading of the trend data.

Ethical Considerations

This study did not involve new data collection. All quantitative metrics came from existing hospital dashboards. The data aggregated and anonymized for internal use. The research team had no access to patient-level identifiers or clinical metadata. The institutional review board approved this comprehensive quantitative assessment. The use of consolidated administrative data adheres to ethical standards for secondary information. Since the data consists of facility-level indicators, the likelihood of identifying specific individuals is non-existent.

As this study exclusively used aggregated, anonymised, facility-level administrative dashboard data with no access to individual patient records or identifiable information, formal informed consent from individual patients was not applicable in the conventional research sense. Institutional authorisation for access to the Ministry of Health dashboard data was obtained through the participating hospitals as part of the study ethics approval process. This clarification is intended to ensure that the ethics reporting accurately reflects the nature of the data used.

Analytical Philosophy

This study uses a pragmatic analytical perspective. We treated hospital dashboard indicators as exploratory signals, not as statistically validated measures. This is due to their administrative purpose, variable definitions, and inconsistent completeness. The analysis focused on identifying directional patterns and variations between hospital types. We avoided inferential testing or claims of causation. This approach aligns with established guidance for RHIS research in transitional health systems.

This perspective holds that transitional systems are better for directional learning than for hypothesis testing. Dashboards show trends and variations. They help identify where implementation needs adjustment. Accordingly, indicators are treated as suggestive rather than conclusive throughout this paper. Interpretive language has been deliberately chosen to reflect this cautious stance, and the phrase "reliable analysis" has been avoided given that the study explicitly acknowledges inconsistency and incompleteness in the underlying data. Consistency between the analytical philosophy and the study's claims is maintained throughout.

Analytical Approach

The analysis was conducted in structured phases. First, we compiled all available monthly dashboard data from 2019 to 2023 for both hospital types. We performed thorough checks for completeness to find any gaps or irregularities. Table 2 summarizes the performance indicators used, their sources, limitations, and analytical treatment.

Second, we calculated descriptive statistics like means, medians, and ranges. This was to provide a general overview of each indicator's distribution, not to determine statistical significance.

Third, we created time-series charts for each indicator. These visuals illustrated changes over the transition period, showing upward, downward, or fluctuating trends. We described these patterns without making claims of improvement or decline.

Fourth, we compared the relative differences between clustered and non-clustered hospitals. These comparisons helped identify divergences between the two organizational models. The findings augmented insights from the qualitative part of the broader research. However, we viewed the indicators as directional signals, not as proof of clustering's causal impact.

Throughout the analysis, we treated the data as indicative rather than as validated metrics. We reported inconsistencies like missing months or definitional changes without adjusting the values. This transparency is central to our pragmatic methodological approach. It uses normal administrative data as reflective, context-sensitive evidence rather than definitive proof.

Overall, the characteristics of the dashboard data, their known limitations, and the pragmatist analytical stance collectively shape how the indicators can be meaningfully used. Rather than supporting inferential claims, these datasets are best suited for generating descriptive signals and contextual insights. Building on this foundation, the next section outlines the specific analytical procedures used to prepare, examine, and visualise the indicators, detailing how descriptive patterns were derived and presented in a manner consistent with the study's cautious interpretive approach.

Analytical Methods

This section outlines methodologies used to prepare, analysis, and present the descriptive analysis forming the foundation of this exploratory assessment of the SHSTP. The analytical methodologies demonstrate the research's pragmatic approach. Considering ordinary administrative indicators as directional signals, recognizing their importance and limitations. In alignment with the study's fundamental concept, all analyses refrained from inferential testing and causal assertions. Prioritizing clarity, transparency, and interpretive restraint.

Indicator Selection Criteria

Indicators chosen based upon on three primary factors. Alignment with SHSTP objectives, availability in all hospitals, and uniform reporting among clusters.

First, only indicators corresponded with SHSTP metrics incorporated. These included patient-centred care, digital transformation, service efficiency, and clinical quality. This approach was to ensure that trends described would address strategic goals of the transformation. Including enhancing patient experience, expanding digital service, and improving operational coordination across clusters.

Second, indicators have to possess adequate temporal availability from 2019 to 2023. Despite variations in data completeness among hospitals. Those with significant gaps or inconsistent reporting were not included in visual displays and cluster comparisons. This mitigated the potential of misinterpretation stemming from isolated data points.

Third, indicators must demonstrate a minimum threshold of definitional stability among hospitals. Although criteria not always aligned with metrics like patient satisfaction, telemedicine encounters, EMR documentation completeness, bed occupancy, and wait time consistency for descriptive analysis. Indicators exhibiting significant difference, such as specific chronic illness pathway compliance. Indicators, incorporated in descriptive rather than visual representations.

The selection method sought to strike balance thorough coverage of SHSTP domains with the necessity for interpretive caution.

Analytical Tools

All analyses utilized fundamental descriptive analytics, without resorting statistical testing that would suggest strong causal certainty. The aim was to analyze data rather than to "test" hypotheses or assess statistical significance.

We analyzed monthly values of every indicator, utilizing simple descriptive summaries. Like percentages, counts, proportions, and medians. This approach gave us a broad understanding of how the indicators distributed. And their year-to-year fluctuations without claiming absolute precision.

Subsequently, time-series trend plots created to illustrate change over the transformation period. These graphs demonstrated whether indications indicated increasing, stable, or changing trends. They were not regarded as indicators of progress or regression. But as illustrative representations of the temporal behaviour of performance metrics.

We performed basic cluster-type comparisons to examine descriptive trends among hospitals based on whether they were clustered or not. Our findings indicated notable distinctions, such as greater utilization of telemedicine and improved EMR completeness in clustered settings. Though these regarded as observed patterns rather than estimated impacts. The analysis was conducted with an exploratory approach and did not involve regression coefficients, p-values, or significance tests.

During this phase, analytical tools were simple, prioritizing transparency and interpretability over complexity.

Triangulation Strategy

Considering specific operational policy context when interpreting collected indicators in various organizational settings. To improve clarity of descriptive trends and limitations of administrative dashboards. Triangulation strategy implemented using non-qualitative sources.

First, comparisons made between the patterns in the dashboards and various official documents. Including SHSTP policy documents, implementation circulars and reporting guidelines. These materials provide insights of specific instances of definitional updates, rollout phases, and digital-system upgrades. Any changes in the indicators deal like operational milestone than assumed performance shifts.

Secondly, dashboard trends were analyzed alongside with internal reporting notes, metadata descriptions, and system change logs sent to hospital management. These records often illustrated instances of missing data, alterations in calculation methodologies, or temporary interruptions resulting from digital platform transfers, factors that directly influence the behavior of routine indicators.

This contextual triangulation was not intended to validate dashboards statistically or inferentially. Rather, it served to establish context and interpret the indicators as directional signals. Ensuring any observed patterns considered with careful caution and understanding of the operational environment in which the data collected.

Presentation Format

The results presented in a mix of graphs, tables and short descriptive summaries. Such formats selected for their reader-friendly and visually intuitive nature. Reflecting indicator trends without relying on the misleading accuracy of inferential statistics.

Trend plots were especially effective in depicting direction,whether upward, stable, or variable. Without suggesting that these patterns indicated statistically validated enhancements. Tables employed to summarize indicator ranges and comparative disparities among cluster types.

The goal was to enable readers to observe the patterns in the visuals. And acknowledge that they represent signals, rather than statistical proof. This approach is consistent study's dedication to interpretive modesty and transparency. Focusing on what the data can demonstrates while remaining truthful about its limitations.

The selection criteria, descriptive tools, triangulation strategy, and presentation format provide a consistent and transparent approach for analyzing routine indicators in a reformed health system. These strategies interpret data as directional indicators rather than proof of performance change. With this framework established, the next section presents observed patterns in patient experience, efficiency, occupancy, and digital transformation indicators. It demonstrates how these signals develop across both clustered and non-clustered hospitals. And among different regions during SHSTP implementation.

RESULTS

The following section presents descriptive patterns from the routine hospital indicators examined between 2019 and 2023, drawing on data from four hospitals across two regions Mecca and Al-Sharqiyyah, as the Focus of this study is exploratory, the findings interpreted as directional indications, rather than confirmed statistical results. All data visuals depict trends and do not suggest any inferences, with a footnote noting that dashboard completeness differed among hospitals and years (completeness < 100%).

Overall Trends in Service Performance

Patient Satisfaction: During transformation phase, patient satisfaction indicates a progressive increase, with minor variations. That seems to align with operational changes shown in policy circulars. Both clustered and non-clustered hospitals showed a general upward directional pattern, though the trajectory was more consistent in clustered settings. Monthly fluctuations were present throughout, and the satisfaction trend should be read as a directional signal consistent with SHSTP patient-centred care priorities, not as confirmed evidence of measurable performance improvement. Exact satisfaction values are not reported in the main text given known sampling differences and missing months, but the overall directional pattern was consistently upward across the later years of the study period.

Waiting Times

Indicators for both outpatient and emergency wait times show a mild downward trend. Though there have been occasional increases during system changes or reporting adjustments. Emergency wait times seem to exhibit greater variability than outpatient wait times. Indicating disparities in rush, surge periods, and operating capacity among hospitals. The trajectory demonstrates a progressive decline in the later years of the dataset. When digital triage and appointment optimization were extensively adopted. The figure below presents a descriptive time-series illustration of patient satisfaction scores across clustered and non-clustered hospitals. Shaded variation reflects month-to-month fluctuation. It is not possible to confirm from the available data whether these reductions represent operationally meaningful improvements or primarily reflect changes in reporting practices during digital system transitions. Values are exploratory and should be interpreted as directional signals rather than statistically validated trends. As illustrated in Figure 1, patient satisfaction scores demonstrate a broadly upward directional pattern over the study period, with periodic fluctuations reflecting reporting variability and operational transitions.

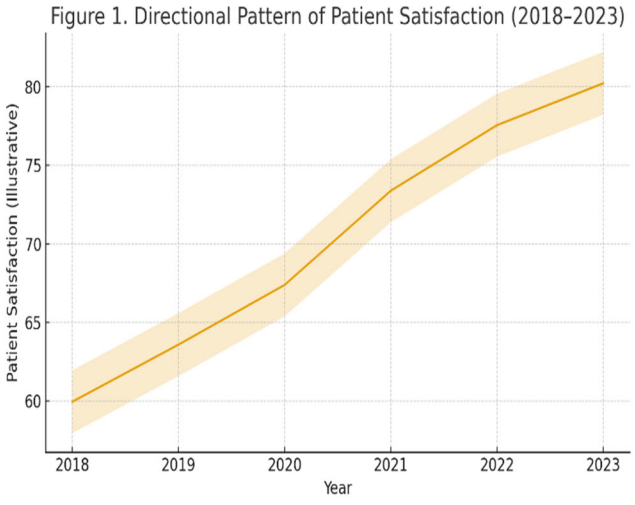

Figure 1: A simple Line Chart Showing Broad Upward Movement With Shaded Regions Reflecting Month-To-Month Variability

Values are exploratory; directional signals only. Dashboard completeness < 100%

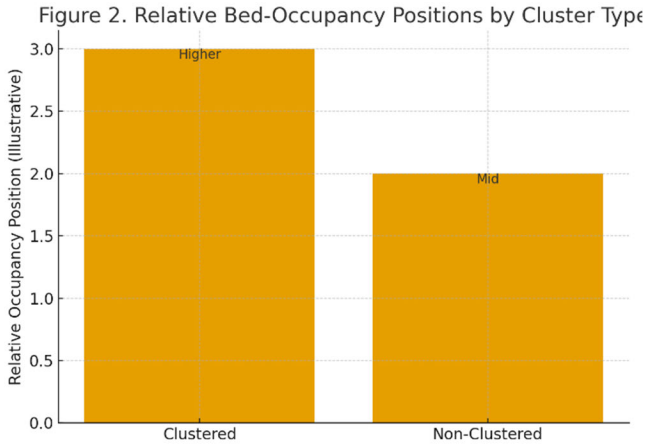

Figure 2: A Descriptive Bar Chart Indicating Relative (Higher / Mid / Lower) Occupancy Levels Across Cluster Categories

Categories represent comparative positioning, not absolute rates. Data are exploratory; completeness < 100%

Variation Between Clustered and Non-Clustered Hospitals

Clustered hospitals illustrate distinct directional trends across several variables compared to non-clustered hospitals. Patient satisfaction in clustered environments shows greater stability and more consistent improvement. We attribute this to the model's organized governance, integrated pathway implementation, and shared-service platforms.

Service Efficiency Indicators

Clustered hospitals exhibit more consistent directional trends in wait times. In contrast, non-clustered facilities show greater erratic oscillations. This suggests significant variation in operations and resource allocation among these facilities.

Occupancy Patterns

Bed occupancy indicators revealed moderate discrepancies. Clustered hospitals exhibited relatively more stable occupancy patterns, though variability remained. Non-clustered hospitals showed more pronounced peaks and dips, consistent with uneven demand distribution and staffing transitions.

It must be emphasised that with only two hospitals in each category, these comparisons should be treated with considerable caution. They may suggest preliminary patterns but do not support broad conclusions about the relative performance of clustered versus non-clustered governance models. Any observed differences require confirmation through larger, more representative samples before generalisable claims can be made.

Figure 2 summarizes relative bed-occupancy positions across clustered and non-clustered hospitals. It highlights greater stability in clustered settings alongside continued variability in whole utilization.

This descriptive comparison illustrates relative occupancy levels across clustered and non-clustered hospitals. Categories represent comparative positioning rather than absolute rates. Data are exploratory, and completeness varies across hospitals and reporting periods.

Regional Variation in Indicator Direction

Regional analysis revealed distinct differences in indicator behaviours. Among hospitals in the Mecca and Al-Sharqiyyah regions. This reflects variations in implementation timing, digital readiness. And organizational context during the SHSTP rollout.

In Mecca, hospitals exhibited more coherent directional patterns. Including gradual improvements in patient satisfaction. General downward trend in outpatient waiting times, and stable bed-occupancy levels. These trends align with Mecca's role as an early implementation region. With more established cluster governance and digital reporting systems.

In contrast, hospitals in Al-Sharqiyyah demonstrated greater variability across several indicators. This was particularly evident in-patient satisfaction, waiting times, and digital measures. Like as EMR documentation completeness. Bed-occupancy patterns also fluctuated more, consistent with phased implementation and transitional service reorganisation.

As with the cluster-type comparisons, regional observations are based on a single hospital per cluster type per region. These findings should be understood as localised, context-specific signals and not as firm regional evidence or as representative of all hospitals in either region. Regional conclusions must be stated and interpreted with this limitation clearly in view.

Digital Health Indicators Across Settings

Digital transformation indicators provide clear directional signals. These comprise telemedicine usage, EMR completion, and the adoption of digital appointment scheduling.

Telemedicine Utilization

Telemedicine encounters illustrate a notable increasing trend, especially following mid-implementation modifications. Clustered hospitals appear to adapt more at the double. This is likely due to their access to integrated digital systems and standardized reporting protocols. However, it is important to distinguish between increased digital tool adoption and confirmed service improvement. A rise in telemedicine encounters signals growing digital capacity but does not in itself demonstrate that care quality or patient outcomes improved as a result of this adoption.

EMR Documentation Completeness

EMR completeness shows a consistent upward trend. However, initial inconsistencies and changes in definitions led to varied patterns early on. Clustered hospitals exhibit more coherent trajectories, indicating enhanced governance alignment.

Table 3: Directional Summary of Indicator Behaviour (2019–2023)

Indicator	Direction	Interpretation (Exploratory)
Patient Satisfaction	↑	Gradual upward trend with fluctuations
Outpatient Wait Time	↓	Signals mild directional reduction; operational significance cannot be confirmed
Emergency Wait Time	↕ / ↓	Fluctuating with modest downward direction
Bed Occupancy	↕	Variable, more stable in clustered hospitals
Readmission Ratio	↕	Inconsistent signals with no clear direction; interpretation further limited by definitional changes during the study period
Telemedicine Encounters	↑↑	Strong upward adoption pattern: reflects growing digital uptake, not confirmed service improvement
EMR Documentation	↑	Improving documentation completeness

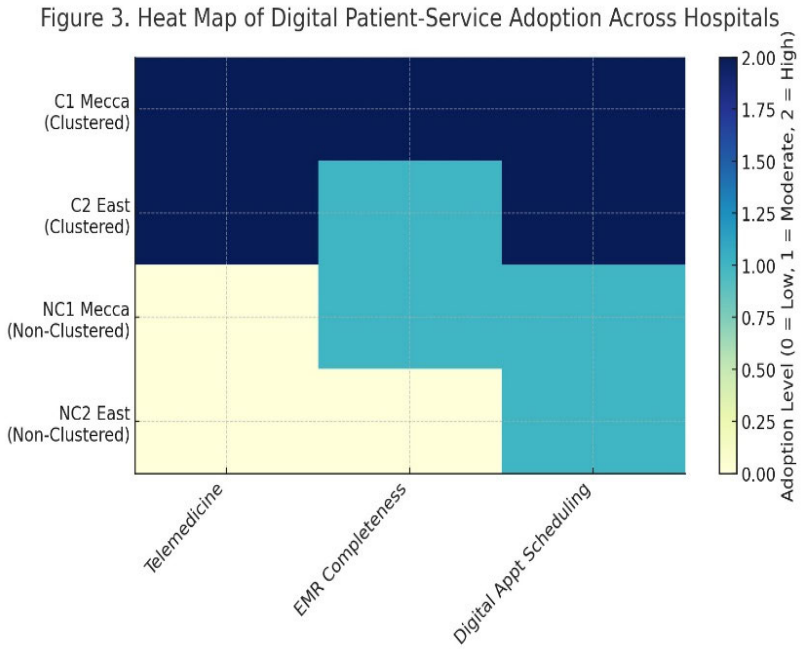

Figure 3: Colour-Coded Relative Adoption Levels Across Facilities: Low → Moderate → High
Data are exploratory; completeness < 100%

Digital Appointment Scheduling and Virtual Follow-Up

Digital scheduling and virtual follow-up metrics exhibit significant growth. Hospitals in Mecca display earlier and more consistent implementation. Non-clustered hospitals exhibit more pronounced fluctuations, aligning with their staggered deployment schedules. As with telemedicine, this growth in adoption should be read as evidence of increased digital uptake rather than as confirmed improvement in service delivery outcomes.

Figure 3 displays color-coded relative adoption levels across facilities (low → moderate → high). Note: Data are exploratory; completeness < 100%. Digital health indicators display stronger adoption signals across hospitals. With variation by region and governance structure.

Table 3 provides a comprehensive breakdown of directional signals across all indices. It complements the visual patterns depicted in Figures 1–3. The table summarizes observed changes in each indicator as upward, downward, variable, or strongly upward. This facilitates clearer comparisons across areas. Such as patient experience, service efficiency, occupancy, and digital transformation. It also helps contextualizing individual indicator patterns within the larger behavioral landscape of SHSTP implementation. This supports our cautious, signal-based approach to interpretation.

Overall, the descriptive indicators suggest that some areas of the SHSTP are showing positive directional signals particularly in digital adoption and patient satisfaction while other areas, including readmission ratios and bed-occupancy patterns, remain variable and difficult to interpret reliably. These mixed signals reflect the inherent complexity of large-scale health system reform. They should serve as a starting point for further investigation rather than as conclusions about performance impact and should be read in the context of the small four-hospital sample from which they are drawn.

DISCUSSION

This study analyzed performance indicators from hospitals in Saudi Arabia during the implementation of the Health Sector Transformation Program (SHSTP). We considered these indicators as exploratory signals rather than conclusive evidence of change. The goal was not to test hypotheses or

measure program impact. Instead, we aimed to provide a cautious, descriptive account of variations between clustered and non-clustered hospitals from 2019 to 2023. We examined patient experience, service efficiency, occupancy patterns, and digital health indicators. This discussion interprets these findings in relation to existing literature and the context of national reform. It also addresses methodological considerations for health systems experiencing digital transformation.

Summary of Key Findings

During the transformation period, patient satisfaction demonstrated a steady increase. Waiting times displayed a slight decrease, especially in outpatient environments. Clustered hospitals showed more consistent and stable trends in areas. Like bed occupancy and telemedicine use. In contrast, non-clustered hospitals had more variable patterns.

Regional disparities were also evident. Mecca hospitals had more stable digital health trajectories. While hospitals in the Eastern Province demonstrated more erratic trends. Digital measurements like EMR completeness, telemedicine visits, and digital scheduling consistently improved. However, some inconsistency remained due to changes in reporting methods and digital system upgrades.

Critically, readmission ratios and bed-occupancy patterns remained variable throughout the study period and did not demonstrate clear directional improvement, even in clustered facilities. This absence of consistent signal in these indicators is an important finding. It may reflect ongoing challenges in care coordination, data recording practices, or genuine service delivery issues possibilities that the present dataset cannot reliably differentiate. Future evaluations should specifically prioritise these stagnant or inconsistent indicators as areas requiring further investigation and stronger methodological tools.

Interpretation in Light of International Evidence

During the transformation period, patient satisfaction demonstrated a steady increase. Waiting times displayed a slight decrease, especially in outpatient environments. Clustered hospitals showed more consistent and stable trends in areas. Like bed occupancy and telemedicine use. In contrast, non-clustered hospitals had more variable patterns.

Regional disparities were also evident. Mecca hospitals had more stable digital health trajectories. While hospitals in the Eastern Province demonstrated more erratic trends. Digital measurements like EMR completeness, telemedicine visits, and digital scheduling consistently improved. However, some inconsistency remained due to changes in reporting methods and digital updates.

These results align with the SHSTP's focus on patient satisfaction and technological advancements. However, they should approached with caution. Due to recognized challenges in the comprehensiveness and consistency of regular dashboards.

Interpretation in Light of International Evidence

Patient Experience Trends: The rise in patient satisfaction aligns with previous studies. These studies shows that restructuring, accountability systems, and digital investments enhance care quality. Similar patterns seen in Qatar, UAE, and Singapore. As they underwent health system changes. Patient experience ratings showed gradual improvement after operational reforms [20,21]. Furthermore, research on patient-centered transformation. Highlighting minor enhancements in satisfaction shows larger cultural shifts [22]. The slight increase noted in this study aligns with these global trends. However, given the limited sample size and data quality constraints in this study, any direct comparison with international evidence should be made with caution.

Service Efficiency and Waiting-Time Reductions

The slight decrease in wait times aligns with research on digital triage. Like appointment optimization, and EMR integration. These are key aspects of the SHSTP known to enhance service efficiency [23, 24]. Fluctuations in emergency wait times reflect global observations. Emergency departments are susceptible to staffing cycles and operational interruptions [25]. The characteristics identified in Saudi hospitals align with anticipated transitional behavior during reforms.

Clustered vs. Non-Clustered Hospitals

Clustered hospitals had more stable trends across various metrics. This reflects findings from integrated care systems in Canada, Scotland, and New Zealand. Consolidation of governance often enhances coordination and digital integration [26]. Studies show that organizations implementing cluster-like reforms gain initial benefits in administrative alignment and digital preparedness [27]. Contrary, decentralized or independent facilities often struggle more when implementing digital standards [28]. However, this study includes only two hospitals per cluster type, and these observed differences must therefore be treated as very preliminary signals. They require replication in substantially larger samples before any generalisation about the relative value of clustered versus non-clustered governance is warranted.

Regional Variation

The distinction between digital indicators in Mecca and the Eastern Province mirrors wider evidence. The timing of regional implementation impacts data patterns during transformation. International research from Australia and UK shows that digital healthcare adoption often follows staggered regional trends. This results in temporarily uneven reporting environments [29]. Our results align with these known patterns.

Digital-Health Indicators

The significant rise in telemedicine use, EMR documentation completeness, and digital scheduling aligns with global trends. Studies in the Middle East and Europe demonstrate rapid growth in telehealth from 2020 to 2023 [30]. Moreover, improvements in EMR completeness correspond with studies. Indicating documentation quality improves as

physicians acclimate to digital procedures [31]. Patterns show Saudi hospitals aligning with local reform. Prioritizing and international movements toward digital healthcare. Nonetheless, increased digital adoption should not be conflated with confirmed service improvement. Growing use of digital platforms is a necessary precondition for performance enhancement but does not in itself demonstrate that care outcomes have improved. This distinction should be maintained clearly when interpreting and communicating the findings of this study.

Policy Interpretation and Implications for SHSTP

The directional indications identified SHSTP aligned with its objectives. This is especially true for enhancing patient experience and progressing digital capabilities. The consistency of indicators among grouped hospitals suggests. That the cluster model may promote more effective operational management.

Nonetheless, these findings should not be construed as proof of causal system enhancement. Instead, they emphasize areas of initial progress and persistent obstacles. They highlight the need for policy focus on:

- Establishing standardized definitions for indicators across regions
- Augmenting data integrity via integrated digital reporting systems
- Assisting non-clustered hospitals in minimizing variability during the transition
- Advancing regional capacity-building for the adoption of digital health
- Enhancing transparency and documentation of system updates

These consequences correspond with global guidelines for assessing health system reforms. Including stability, data control, and continuous learning [32].

Methodological Contribution: Pragmatist Use of Routine Data

A notable aspect of this study is its pragmatic analytical viewpoint. We view routine indicators as directional signals rather than strong statistical proof. This perspective is gaining traction in health systems research. Particularly where data infrastructures are developing [33]. By acknowledging limitations and avoiding overinterpretation. The study showcases the potential of routine data to:

- Illuminate nascent behavioral trends
- Facilitate policy contemplation
- Highlight areas necessitating further validation
- Augment future research employing more stringent methodologies

This methodology offers a framework for nations experiencing digital health transitions with developing reporting systems.

Limitations

Several limitations exist. First, data inconsistencies occurred. Such as missing months and varied adoption rates among hospitals. Second, indicator descriptions changed throughout the study, reducing comparability between years. Third, administrative data could be influenced by reporting bias. Especially when linked to managerial KPIs. Fourth, the research exclusively used descriptive techniques without statistical modeling. Finally, the use of aggregated data meant individual patient variations could not be examined.

Most critically, the four-hospital sample drawn from two regions places substantial limits on the generalisability of these findings. The results of this study cannot be applied to the broader Saudi national healthcare system and should not be interpreted as representative of Saudi hospital performance overall. They represent localised, context-specific, exploratory observations from a small regional sample at varying stages of SHSTP implementation. Any policy interpretation or future citation of these findings should be accompanied by this caveat explicitly.

Ongoing investment in Saudi Arabia's health information governance is crucial. This highlights the importance of harmonized reporting systems, transparent metadata, and strengthened data quality frameworks.

Addressing Limitations in the Use of Routine Indicators

To address these limitations, future evaluations should implement practical measures: greater standardisation of indicator definitions to improve comparability; enhanced data governance through clearer metadata and transparent documentation; strengthened capacity of hospital data teams to reduce reporting gaps; and more systematic linkage of routine indicators with policy timelines to improve contextual interpretation. Future studies should also consider more rigorous analytical designs. Interrupted time-series analysis, for example, would allow more precise examination of whether observed changes in indicators coincide with specific SHSTP implementation milestones, while mixed-method reform evaluation would provide both statistical evidence and contextual depth that the present study cannot offer.

Reflexivity and Lessons Learned

Evaluating large-scale reform using routine administrative indicators requires self-awareness. The authors conducted this evaluation from a dual position — as analytically detached observers capable of recognising data inconsistencies as meaningful methodological features, and as evaluators with direct access to institutional dashboards providing insight into implementation context. Maintaining this balance required ongoing reflection to avoid over-interpreting directional patterns or assuming causality from descriptive signals.

Access to dashboard data was bounded by institutional regulations. Data were limited to aggregated facility-level measures, with certain quality and financial metrics unavailable, and historical completeness varying by hospital.

These constraints shaped the analytical approach, reinforcing the emphasis on careful, context-specific interpretation.

Three key methodological insights emerged from this process. First, working within data constraints promotes analytical rigour the pragmatic approach suited the administrative data environment and encouraged careful analysis over hasty conclusions. Second, transparency functions as a form of rigour explicitly documenting missingness and definitional changes enhanced the study's methodological credibility. Third, cross-source triangulation adds interpretive depth comparing quantitative trends with policy documents and system metadata helped contextualise implementation milestones and reduce misinterpretation.

Researchers working in similar data-limited settings are encouraged to: apply triangulation by linking quantitative indicators with documentary records and implementation timelines; state limitations such as missing data and definitional changes explicitly and early; use visual aids to illustrate directional patterns without implying causation; prioritise exploratory framing and avoid terms such as "impact" or "effect"; and collaborate with institutional data and IT teams to understand how indicators are generated and what interpretation risks apply.

Figure 4 illustrates triangulation approach in this study to contextualize routine quantitative indicators. through policy documents, operational metadata, and implementation timelines.

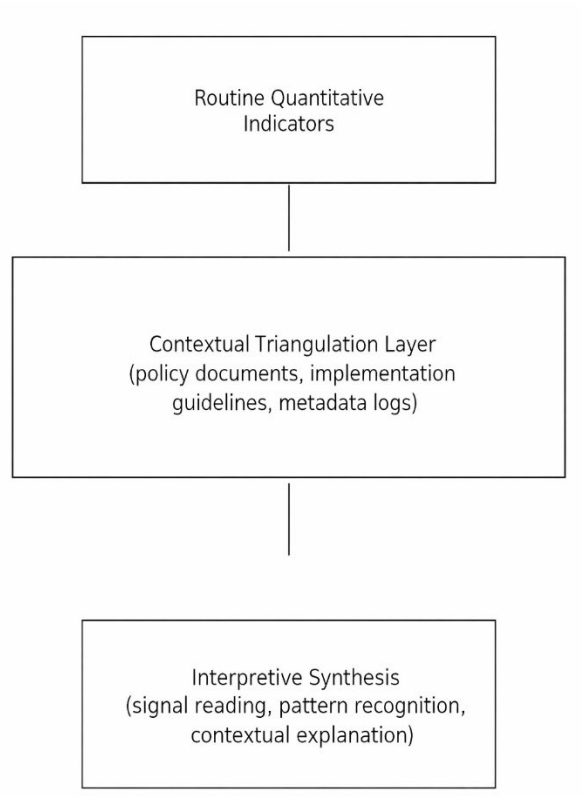

Figure 4: A Schematic Summarising the Reflexive Method used in this Study, Showing How Exploratory Quantitative Signals Were Contextualised through Documentary and Operational Evidence

CONCLUSIONS

This study's exploratory analysis offers a measured perspective on quantitative service indicators during the SHSTP. By treating routine administrative metrics as directional signals, patterns suggesting gradual improvement were identified in patient satisfaction, digital service use, and documentation completeness. However, uneven progress was also observed in wait times, occupancy rates, and readmission figures.

These findings must be understood within the constraints of the study's design. The evidence presented is signal based, not proof of performance impact. The four-hospital sample and the reliance on administrative dashboard data with known inconsistencies and definitional instability mean that results should be treated as preliminary and context-specific, not as a definitive assessment of SHSTP performance or as nationally generalisable conclusions. Progress appears to be occurring in some domains, but it is uneven, influenced by operational and reporting circumstances, and cannot be causally attributed to the SHSTP through this analysis alone. The findings are most appropriately characterised as an exploratory, regional case-based commentary on health system indicators during a period of reform, rather than as a performance evaluation of the programme.

Future Research Directions

Future research should expand this signal-based, exploratory approach to a broader national sample of hospitals, which would support a more comprehensive understanding of SHSTP implementation across Saudi Arabia. Applying the same analytical framework to hospitals at different stages of clustering and digital maturity would clarify how routine indicators behave across diverse implementation settings. National-level studies could examine variations between regions, cluster types, and service models to support more systematic monitoring of reform progress.

In terms of analytical design, future studies would benefit significantly from adopting interrupted time-series analysis, which would allow more precise examination of whether observed changes in indicators coincide with specific reform milestones. Mixed-method reform evaluation designs combining quantitative trend analysis with qualitative investigation of organisational processes would also provide a more complete picture of how and why performance indicators change during SHSTP implementation. Maintaining the cautious and contextualised interpretation of routine data advocated in this study remains important regardless of the analytical method employed.

Policy Implications

As the SHSTP progresses, it is crucial to improve the Kingdom's health information infrastructure. The differences noted among regions and hospital types. Highlighting the magnitude of this transformation. To ensure more accurate and comparable assessments. The Ministry of Health (MOH) could implement three strategic measures.

First, unified data standards are essential. Aligning indicator definitions for measures like readmission rates and wait times would reduce variation between hospitals. It would also increase trust in national reports. The progress of other countries shows standardization accelerates system growth by enhancing the reliability of routine indicators.

Second, developing data stewardship skills is vital. The variations noted in this research were partly due to inconsistent documentation and digital preparedness. Improving the workforce's ability to enter data. Ensuring quality, and review analytics would reduce administrative errors and improve monitoring accuracy.

Third, a culture of transparent evaluation is important. As the SHSTP evolves, it will produce varied data. Acknowledging the shortcomings of standard metrics is crucial for evidence-based policy. The MOH can foster an environment where clusters openly discuss reporting difficulties. This will cultivate an evaluation mindset that prioritizes precision over inflated performance claims.

Research Implications

This study offers methodological contributions for researchers working in health systems with developing data infrastructure. By using a pragmatic, signal-based approach, it demonstrates that routine dashboards can provide useful directional insights even when they do not meet the standards required for inferential analysis. Rather than disregarding imperfect data, researchers can examine trends and cross-check signals against policy documents and system metadata to improve contextual interpretation.

In summary, this study demonstrates that cautious, transparent quantitative assessment in transitional health systems can provide useful directional insights even when data quality is imperfect and sample sizes are small. It does not claim to have measured the impact of the SHSTP. Instead, it offers a signal-based analytical contribution that can inform the design of more rigorous future evaluations. As Saudi Arabia advances its transformation under Vision 2030, this kind of methodologically honest, contextually grounded analysis can contribute meaningfully to evidence-informed national health policy provided its exploratory nature and significant limitations are clearly understood and communicated.

Author Contributions

Conceptualization, A.A.A. (Ahmed Abdullah Alshehri) Methodology, A.A.A. (Ahmed Abdullah Alshehri); validation, A.A.A. (Ahmed Abdullah Alshehri) Formal analysis, A.A.A. (Ahmed Abdullah Alshehri);Investigation, A.A.A. (Ahmed Abdullah Alshehri); Resources, A.A.A. (Ahmed Abdullah Alshehri); data curation, A.A.A. (Ahmed Abdullah Alshehri); writing original draft preparation, A.A.A. (Ahmed Abdullah Alshehri); writing review and editing, A.A.A. (Ahmed Abdullah Alshehri) and A.A.A. (Asaad Abdulrahman Abduljawad); Supervision, David Rea. All authors have read and agreed to the published version of the manuscript.

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Institutional Review Board Statement

The study was conducted in accordance with the Declaration of Helsinki and approved by the Research Ethics Committee of the College of Health Sciences at Swansea University code 280818 on 12 July 2019 and Umm Al-Qura University, code 2021/007, Saudi Arabia on 23 February 2021.

Informed Consent Statement

This study used exclusively aggregated, anonymised, facility-level administrative dashboard data. No individual patient records or identifiable personal data were accessed at any stage of the research. Formal informed consent from individual patients was therefore not applicable in the conventional sense for this study. Institutional authorisation for access to the Ministry of Health dashboard data was obtained through the participating hospitals as part of the institutional ethics approval process.

Data Availability Statement

The data used in this study were obtained from internal hospital performance dashboards administered by the Saudi Ministry of Health. These datasets contain aggregated operational indicators that are not publicly available due to institutional governance, confidentiality agreements, and restrictions on the release of administrative health information. As no new data were generated by the authors, and access to the underlying datasets is limited, the minimal aggregated dataset required to understand the study's analytical structure is provided in the Supplementary Materials (Table S1). Additional data may be available upon reasonable request to the Ministry of Health, subject to institutional approval.

Reporting Standards

This study drew on key principles of the RECORD (REeporting of studies Conducted using Observational Routinely-collected health Data) checklist as a guide for transparent and reproducible reporting of routine administrative data research. Relevant RECORD items informed the structure of the methods, data limitations, and analytical transparency sections throughout the manuscript.

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Conflicts of Interest

The authors declare no conflicts of interest. The funders had no role in the design of the study; in the collection, analyses, or interpretation of data; in the writing of the manuscript; or in the decision to publish the results.

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