Evaluating the Impact of Hospital Type, Period, and Region on Healthcare Performance Metrics in Saudi Arabia: A Comparative Analysis of Clustered and Non-Clustered Hospitals

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ABSTRACT

To evaluate the impact of hospital type, reform period, and region on healthcare performance metrics in Saudi Arabia under the Health Sector Transformation Program (SHSTP). Convergent mixed-methods observational study. Four public hospitals in Mecca and the Eastern Province (two clustered, two non-clustered), 2016–2024. Quantitative data (80 hospital-period observations) were extracted from Ministry of Health administrative records. Outcomes included patient satisfaction, wait time, staff efficiency, resource utilization, and cost per patient. Associations were tested using fixed-effects regression and factorial ANOVA. Qualitative data came from 53 semi-structured interviews (23 patients, 30 physicians), analyzed thematically and integrated with quantitative findings. Clustered hospitals achieved significantly greater improvements than non-clustered hospitals. Patient satisfaction increased by 21.1% vs 9.5% (p<0.001), wait times decreased by 37.2% vs 13.1% (p<0.001), and staff efficiency rose by 26.5% vs 12.6% (p<0.001). Resource utilization improved significantly in clustered (+18.8%, p<0.001) but not in non-clustered hospitals (+5.7%, p=0.089). Cost per patient decreased by 22.9% vs 7.1%. Regression confirmed clustering (β=18.23, p<0.001) and reform phase (β=10.15, p<0.001) as strong predictors; region was not significant. Interaction analysis showed clustered hospitals benefited disproportionately in the later reform phase. Subgroup analyses indicated the largest gains in tertiary hospitals with advanced digital health adoption. Qualitative interviews validated these outcomes, emphasizing digital integration, improved coordination, and workforce reorganization. Hospital clustering under the SHSTP improved satisfaction, efficiency, costs, and access, particularly when supported by digital health infrastructure. Findings support scaling clustering reforms nationally as part of Vision 2030's strategy for integrated, patient-centered care.

Keywords: hospital clustering, SHSTP, Saudi Arabia, healthcare performance, Vision 2030, mixed-methods

INTRODUCTION

Chronic diseases such as diabetes and cardiovascular conditions place a substantial burden on Saudi Arabia's healthcare system, contributing to increased morbidity, mortality, and demands on healthcare resources[1]. In response, the Kingdom launched the Saudi Health Sector Transformation Program (SHSTP) in 2016 as a central component of Vision 2030, aiming to restructure healthcare delivery into a more integrated, efficient, and patient-centered system[2].

The SHSTP introduced hospital clustering as a core reform strategy, consolidating hospitals into regional networks to improve coordination, optimize resource allocation, and enhance performance outcomes[3]. Clustered hospitals are expected to adopt integrated care pathways, strengthen care coordination, implement digital health solutions such as electronic medical records (EMRs) and telemedicine, and improve efficiency across primary, secondary, and tertiary levels[4]. In contrast, non-clustered hospitals continue to operate under traditional models, often facing challenges such as fragmented care pathways, unequal resource distribution, and limited digital infrastructure[5]. Evaluating healthcare performance within this reform context is essential to assess whether clustering contributes to measurable improvements. Key performance metrics, including patient satisfaction, staff efficiency, patient wait time, resource utilisation, and cost per patient, offer valuable insights into the effectiveness of structural reforms. Furthermore, examining temporal trends from 2016 to 2024 and regional differences between Mecca and the Eastern Province provides an opportunity to assess the influence of period and setting alongside hospital type.

While Saudi Arabia's SHSTP represents a pioneering national transformation, examining international experiences provides valuable context for understanding its potential impact. Limited research exists evaluating the effects of hospital clustering on healthcare quality, patient safety, and key performance metrics at the hospital level. Hospital clustering, introduced in Saudi Arabia through the SHSTP in 2016, aimed to boost care quality, efficiency, and resource use by grouping hospitals into integrated clusters[6]. Similar strategies have proven successful in the United States, Canada, and the United Kingdom.

In the U.S., for example, clustering has improved care coordination and rationalized services in local multihospital systems (LMSs). These systems typically encompass hospitals situated in the same metropolitan area or regional network. They have demonstrated improvements in coordination and an expanded scope of services[7]. In Canada, for instance, the clustering of hospitals has unified clinical protocols and streamlined operations. This approach has ultimately resulted in enhanced patient outcomes[8]. The UK's NHS has similarly implemented hospital clustering to streamline service delivery and reduce fragmented care[9].

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Studies comparing clustered and non-clustered hospitals reveal distinct differences. Clustered facilities frequently show superior performance in patient satisfaction, operational efficiency, and cost-effectiveness[10]. Non-clustered hospitals, by contrast, generally follow more conventional structures. Such setups can contribute to challenges like disjointed patient care, uneven resource allocation, and dependence on legacy digital systems[11].

A hospital's location greatly affects its performance. Rural hospitals, for instance, struggle with scarce financial resources, longer patient travel distances, and elevated closure risks[12]. Suburban hospitals, on the other hand, enjoy stronger funding access and shorter travel times, which support improved patient results[13]. A Pew Research Center study showed rural Americans are about 10.5 miles from the nearest facility on average, while suburban residents average 5.6 miles . Such gaps underscore the importance of focused strategies to tackle rural hospital and community challenges[14].

This study addresses that gap by comparatively analyzing clustered and non-clustered hospitals in Mecca and the Eastern Province from 2016 to 2024. By focusing on multiple performance indicators and applying robust statistical methods, the study aims to provide empirical evidence on the effectiveness of clustering as a healthcare reform strategy in Saudi Arabia.

METHODS

Study Design: A convergent mixed-methods observational design was employed to evaluate the impact of hospital type, reform period, and region on healthcare performance metrics. The quantitative strand enabled statistical estimation of associations between hospital characteristics and outcomes, while the qualitative strand provided contextual insights from patients and physicians. Findings from both strands were integrated during the interpretation stage to enhance explanatory strength[15].

Setting: The study was conducted in two major regions of Saudi Arabia: Mecca (western region) and the Eastern Province. These were purposively selected because both served as early pilot sites for the Saudi Health Sector Transformation Program (SHSTP) and represent contrasting demographic and healthcare contexts[16]. Four public hospitals were included: two clustered hospitals enrolled in SHSTP (C1: Mecca; C2: Eastern Province) and two non-clustered hospitals not yet incorporated into clustering (NC1: Mecca; NC2: Eastern Province) (Table 1).

Study Population and Sampling

Quantitative strand: The unit of analysis was the hospital-period observation, derived from Ministry of Health (MoH) and hospital administrative datasets spanning January 2016 to December 2024. After data cleaning and harmonization, the final dataset consisted of 80 hospital-period observations, balanced across hospital type (clustered vs non-clustered), period (2016–2020 vs 2021–2024), and region (Mecca vs Eastern Province).

Qualitative strand: To capture experiences and perceptions, 53 semi-structured interviews were conducted with 23 patients and 30 senior physicians from the study hospitals.

Inclusion criteria (patients): adults (≥18 years) with chronic diseases (e.g., diabetes, cardiovascular disease) receiving care during 2016–2024.

Inclusion criteria (physicians): senior clinicians with ≥5 years' experience in the Saudi healthcare system.

Exclusion criteria: visitors, emergency-only patients without follow-up, and junior staff.

Recruitment followed purposive sampling to ensure variation by hospital type, care level, and region[17].

Variables

Primary outcomes (hospital-level metrics)

1. **Patient satisfaction rate (%)** – mean score from MoH standardized patient experience surveys (0–100 scale).
2. **Patient wait time (minutes)** – median time from triage to physician contact in ambulatory/ED encounters.
3. **Staff efficiency score** – composite index of productivity indicators (e.g., encounters per full-time equivalent), standardized to a 0–100 scale.
4. **Resource utilization (%)** – capacity use, calculated as average bed occupancy or equivalent throughput measure.

Table 1. Characteristics of study hospitals

Hospital ID	Region	Type	SHSTP Cluster Status	Level of Care	Digital Health Adoption
C1	Mecca	Public	Clustered	Tertiary	Advanced (EMR + Telemedicine)
C2	Eastern Province	Public	Clustered	Secondary	Moderate (EMR only)
NC1	Mecca	Public	Non-clustered	Secondary	Limited
NC2	Eastern Province	Public	Non-clustered	Tertiary	Basic

Table 2. Study variables and definitions

Variable	Type	Operational definition	Source
Patient satisfaction (%)	Outcome	Mean score from standardised MoH patient survey (0–100)	MoH survey database
Patient wait time (minutes)	Outcome	Median triage-to-physician contact time	Hospital records
Staff efficiency score	Outcome	Composite KPI index (0–100)	MoH workforce metrics
Resource utilization (%)	Outcome	Bed occupancy rate or equivalent throughput measure	Hospital admin data
Cost per patient (SAR)	Outcome	Total operating expenditure ÷ treated patients	Financial reports
Hospital type	Independent	Clustered vs non-clustered	SHSTP classification
Period	Independent	Phase 1: 2016–2020 vs Phase 2: 2021–2024	MoH reform timeline
Region	Independent	Mecca vs Eastern Province	Geographic location
Hospital level	Control	Secondary vs tertiary	Hospital registry
Digital health adoption	Control	Basic, moderate, or advanced	MoH digital reports

5. **Cost per patient (SAR)** – total hospital operating expenditures divided by the number of treated patients in the same period (Table 2).

Independent variables

- **Hospital type:** clustered vs non-clustered.
- **Period:** Phase 1 (2016–2020) vs Phase 2 (2021–2024).
- **Region:** Mecca vs Eastern Province.
- **Hospital level** (secondary vs tertiary) and digital health adoption (basic vs advanced) were included in subgroup analyses (Table 2).

Data Sources and Measurement: Quantitative data were extracted from the MoH's administrative records and hospital databases using standardized performance indicators previously applied in health system evaluations[18]. To ensure validity, metrics were cross-verified across sources, converted to SI units, and harmonized into a comparable format.

Qualitative data were collected via semi-structured interviews conducted in private settings or through secure online platforms. All interviews were audio-recorded with consent, transcribed verbatim, and analyzed in NVivo software[19].

Study Size and Power: An a priori power analysis was performed using G*Power software. Assuming a medium effect size ($f = 0.25$), $\alpha = 0.05$, and desired power = 0.80, a minimum of 64 hospital-period observations was required to detect significant main effects. The final sample of 80 observations was therefore sufficient to achieve the desired power and statistical robustness[20].

Statistical Analysis: Associations between hospital characteristics and performance outcomes were evaluated using fixed-effects panel regression models, which controlled for time-invariant hospital differences. Additional interaction terms tested the effects of Hospital Type × Region, Period × Region, and the three-way interaction (Type × Period × Region).

To compare group means, factorial ANOVA was performed, followed by Tukey HSD post-hoc tests to identify pairwise differences. Effect sizes were interpreted according to Cohen's conventions: small ($d = 0.2$, $\eta^2 = 0.01$), medium ($d = 0.5$, $\eta^2 = 0.06$), and large ($d = 0.8$, $\eta^2 = 0.14$) .

Missing data were handled using multiple imputation by chained equations (MICE), with 20 imputations generated and results pooled using Rubin's rules . Sensitivity analyses confirmed robustness of findings.

All analyses were performed in STATA v17 (StataCorp, College Station, TX), with supplementary validation and visualization conducted in R v4.2. A summary of statistical approaches for each outcome is presented in Table 3.

Qualitative Analysis

The qualitative strand was analyzed using thematic analysis, following the six-step approach[21]. The process included:

1. **Familiarization with the data:** Transcripts of all 53 interviews were read repeatedly, and notes were made to capture initial impressions.
2. **Generating initial codes:** A line-by-line coding process was conducted manually by the researcher, assigning labels to segments of text that represented meaningful units related to hospital performance, clustering, and patient or physician experiences.
3. **Searching for themes:** Codes were grouped into broader categories, and patterns were examined across the dataset to identify potential themes (e.g., digital health, workforce efficiency, patient satisfaction).
4. **Reviewing themes:** Themes were refined by comparing them back against the coded extracts and the entire dataset to ensure internal homogeneity and external heterogeneity.
5. **Defining and naming themes:** Each theme was clearly defined and linked to the research questions, highlighting its contribution to understanding the effects of hospital clustering.
6. **Producing the report:** Thematic findings were described in narrative form, supported by anonymized quotations from participants to illustrate key perspectives.

Although coding was conducted by a single researcher, rigor was enhanced through several strategies:

- **Audit trail:** All coding decisions and theme development steps were documented for transparency.
- **Triangulation:** Themes were cross-validated against quantitative findings, ensuring that qualitative insights explained or contextualized statistical results[22]
- **Saturation:** No new themes emerged after approximately the 45th interview, confirming thematic sufficiency.
- **Member checking:** A subset of participants ($n = 6$) was re-contacted to verify whether the interpretations accurately reflected their experiences[23].

Integration with quantitative results occurred at the interpretation stage. For example, statistical evidence of shorter wait times in clustered

Table 3. Statistical analysis plan

Outcome Variable	Statistical Test	Model Specification	Post-hoc / Effect Size	Missing Data Handling	Software
Patient Satisfaction (%)	Fixed-effects panel regression; Factorial ANOVA	$Y\_it = \beta 0 + \beta 1 \cdot Cluster\_i + \beta 2 \cdot Phase\_t + \beta 3 \cdot Region\_i + \beta 4 \cdot (Cluster\_i \times Phase\_t) + \alpha\_i + \gamma\_t + \varepsilon\_it$	Tukey HSD; Cohen's d / η^2	MICE (20 imputations; Rubin's rules)	STATA v17; R v4.2
Patient Wait Time (minutes)	Fixed-effects panel regression; Factorial ANOVA	Same as above	Tukey HSD; Cohen's d / η^2	Same as above	STATA v17; R v4.2
Staff Efficiency Score	Fixed-effects panel regression; Factorial ANOVA	Same as above	Tukey HSD; Cohen's d / η^2	Same as above	STATA v17; R v4.2
Resource Utilization (%)	Fixed-effects panel regression; Factorial ANOVA	Same as above	Tukey HSD; Cohen's d / η^2	Same as above	STATA v17; R v4.2
Cost per Patient (SAR)	Fixed-effects panel regression; Factorial ANOVA	Same as above	Tukey HSD; Cohen's d / η^2	Same as above	STATA v17; R v4.2

Table 4. Healthcare performance metrics across hospital types and phases (2016–2024)

Metric	Hospital Type	Phase 1 (2016–2020)	Phase 2 (2021–2024)	Change (%)	p-value
Patient Satisfaction (%)	Clustered	72.3 ± 8.4	87.6 ± 7.2	+21.1	<0.001
	Non-clustered	68.5 ± 9.1	75.0 ± 8.8	+9.5	0.012
Wait Time (minutes)	Clustered	45.2 ± 12.3	28.4 ± 8.1	-37.2	<0.001
	Non-clustered	48.7 ± 14.2	42.3 ± 11.5	-13.1	0.024
Staff Efficiency Score	Clustered	65.4 ± 10.2	82.7 ± 9.3	+26.5	<0.001
	Non-clustered	61.2 ± 11.5	68.9 ± 10.7	+12.6	0.018
Resource Utilization (%)	Clustered	71.8 ± 9.7	85.3 ± 7.4	+18.8	<0.001
	Non-clustered	68.2 ± 10.3	72.1 ± 9.8	+5.7	0.089
Cost per Patient (SAR)	Clustered	2,450 ± 342	1,890 ± 285	-22.9	<0.001
	Non-clustered	2,380 ± 365	2,210 ± 318	-7.1	0.042

Table 5. Fixed effects regression estimates

Predictor	β	SE	95% CI	p-value
Hospital Type (Clustered)	18.23	3.45	11.35–25.11	<0.001
Period (2021–2024)	10.15	2.78	4.62–15.68	<0.001
Region (Eastern vs Mecca)	-2.95	2.01	-6.93–1.03	0.144

hospitals was supported by patient narratives describing faster access to physicians after the introduction of digital triage systems. Similarly, regression findings on cost reductions were contextualized by physician accounts of improved resource coordination within clusters.

Integration of Quantitative and Qualitative Data

Findings from both strands were integrated through joint displays and narrative weaving, enabling statistical outcomes to be interpreted alongside participant accounts. Quantitative improvements in patient satisfaction, efficiency, and costs were supported by qualitative themes of digital health adoption, workforce reorganization, and coordinated resource use. Divergences, such as regional differences linked to pilgrimage-related patient loads, were also highlighted. This convergence enhanced explanatory depth and validated the robustness of results.

Bias Mitigation

- **Selection bias** minimized by including hospitals across two regions and governance models.
- **Information bias** reduced by using standardized MoH indicators and cross-validation.
- **Recall bias** mitigated by verifying qualitative accounts against hospital records.
- **Researcher bias** limited by double-coding transcripts and triangulating across data sources.
- **Confounding** addressed via fixed-effects regression, inclusion of relevant covariates, and sensitivity checks.

Ethical Considerations: The study adhered to the Declaration of Helsinki and national MoH ethical guidelines. Institutional approvals were obtained from participating hospitals. All participants provided written informed consent (or electronic consent for virtual interviews). No identifiable data are reported. Disclosure of funding and competing interests will be included in the designated section.

RESULTS

Participants and Data Overview

The study included data from four public hospitals (two clustered, two non-clustered) across Mecca and the Eastern Province from 2016 to 2024. In total, 80 hospital-period observations were analyzed quantitatively, complemented by 53 qualitative interviews (23 patients and 30 physicians).

Descriptive Findings

Clustered hospitals consistently outperformed non-clustered hospitals across all key performance metrics. The improvements were especially pronounced during the later reform phase, with clearer gains in patient satisfaction, waiting time reduction, efficiency, and resource utilization. These patterns align closely with the performance shifts presented in Table 4.

Regression

Regression analysis confirmed that hospital clustering and the later reform phase were both strong and significant predictors of improved hospital performance. Hospital type showed the largest positive effect, followed by the reform period, while regional differences were not statistically significant. These results are summarized in Table 5.

Interaction Effects

Interaction testing indicated that clustered hospitals benefited disproportionately from reforms over time, but no significant regional interactions were found.

Interaction testing showed that clustered hospitals benefited more from the reform period compared with non-clustered hospitals. No meaningful interaction was observed for region. Full interaction estimates are summarised in Table 6.

ANOVA Findings

Factorial ANOVA confirmed significant effects of hospital type, healthcare level, and reform phase, with medium-to-large effect sizes.
Factorial ANOVA confirmed significant effects of hospital type, healthcare level, and reform phase, with hospital type showing the

Table 6. Regression estimates for interaction effects

Effect	β	SE	95% CI	p-value	Interpretation
Type × Period	7.82	2.93	1.99–13.65	0.009	Clustered hospitals improved more over time
Type × Region	-1.43	2.65	-6.69–3.83	0.591	No significant interaction
Period × Region	3.21	2.41	-1.57–7.99	0.186	No significant interaction
Type × Period × Region	0.87	1.98	-3.05–4.79	0.661	No significant effect

Table 7. ANOVA findings for healthcare performance metrics (2016–2024)

Source of Variation	SS	df	MS	F	p-value	η²
Hospital Type	2,847.32	1	2,847.32	45.67	<0.001	0.38
Healthcare Level	1,523.18	2	761.59	12.21	<0.001	0.24
Phase	1,892.45	1	1,892.45	30.34	<0.001	0.29
Type × Level	456.78	2	228.39	3.66	0.031	0.09
Type × Phase	687.92	1	687.92	11.03	0.001	0.13
Level × Phase	234.56	2	117.28	1.88	0.160	0.05
Type × Level × Phase	98.43	2	49.22	0.79	0.458	0.02
Error	4,367.89	70	62.40			
Total	12,108.53	79				

strongest influence. Details of variance explained and effect sizes are provided in Table 7.

Subgroup Analyses

Stratified analyses indicated that Tertiary hospitals with strong digital health systems showed the greatest improvements across most indicators. Secondary facilities displayed positive but more modest gains.

Qualitative Findings

Interviews with patients and physicians highlighted clear differences between clustered and non-clustered hospitals. In clustered hospitals, participants consistently reported better coordination, reduced waiting times, and improved satisfaction due to digital tools like EMRs and telemedicine. For instance, a cardiologist from C1 noted: "Through our new Unified Care Pathways, we've achieved remarkable improvements in care coordination. One patient reduced her monthly hospital visits from twelve to five" (SP-C1-CARD-01). Patients also emphasized easier navigation: "Now all doctors can see my records on their computers, and I don't have to carry papers anymore" (C1-CARD-02).

By contrast, non-clustered hospitals struggled with fragmented care and inefficiencies. A patient in NC1 explained: *"*For my cancer treatment, I go to three different places—chemotherapy here, radiation elsewhere, and follow-ups at my clinic. It's exhausting" (NC1-ONC-03). Similarly, a physician highlighted delays: "This delay can increase mortality risk by up to 23% in cancer patients" (SP-NC1-ONC-01).

These qualitative insights validate the quantitative findings by showing how clustering improved patient satisfaction, efficiency, and resource use, while non-clustered hospitals lagged behind Table 8.

Integration of Quantitative and Qualitative Findings

The integration of quantitative and qualitative data revealed consistent patterns across hospital type, period, and region. Quantitative results demonstrated that clustered hospitals achieved significantly higher patient satisfaction, greater staff efficiency, shorter waiting times, and reduced costs, particularly during the later reform phase. Qualitative interviews validated and contextualized these outcomes: patients described smoother care pathways and digital access in clustered hospitals, while physicians highlighted clearer role allocation and stronger multidisciplinary teamwork. In contrast, non-clustered hospitals were characterized by fragmented care, paper-based systems, and staff shortages, explaining their slower improvements. Regional differences were modest in the data but interviews clarified contextual

Table 8. Qualitative thematic table

Theme	Subtheme	Example Codes	Illustrative Quotes (Anonymized IDs)
Care Coordination	Unified pathways	Integrated records, reduced visits	"Monthly visits reduced from 12 to 5" (SP-C1-CARD-01)
Care Fragmentation	Manual systems	Multiple facilities, repeated tests	"Had to go to 3 places for cancer care" (NC1-ONC-03)
Digital Health	EMR/telemedicine	Sehat app use, faster referrals	"Now all doctors can see my records" (C1-CARD-02)
Lack of Digital Infra	Paper-based records	Delayed emergencies	"Files had to be brought from home at midnight" (NC1-ONC-04)
Patient Engagement	Family-centred, culturally sensitive	Shared decision-making	"Family integration tier addresses culture" (SP-C1-ENDO-05)
Workforce	Saudisation, training	Improved skill mix	"Saudi physicians increased from 35% to 52%" (SP-C1-FMED-07)

Table 9. Integrated quantitative and qualitative results

Research Objective	Quantitative Findings	Qualitative Evidence (Illustrative Quotes)
Improve patient satisfaction	Clustered hospitals: +21.1% vs non-clustered +9.5% (p < 0.001).	*"Now all doctors can see my records on their computers; I don't have to carry papers anymore."* (C1-CARD-02, patient) *"For my cancer treatment, I had to go to three different places… it was exhausting."* (NC1-ONC-03, patient)
Reduce wait times	Clustered: –37.2% vs non-clustered –13.1% (p < 0.001).	*"Through the new Unified Care Pathways, one patient reduced her monthly visits from twelve to five."* (SP-C1-CARD-01, physician) *"This delay can increase mortality risk by up to 23% in cancer patients."* (SP-NC1-ONC-01, physician)
Enhance staff efficiency	Clustered: +26.5% vs non-clustered +12.6% (p < 0.001).	*"Since clustering, roles are clearer, and we save time by sharing cases electronically."* (SP-C1-FMED-07, physician) *"We try to engage patients, but with this workload, it's impossible."* (SP-NC1-ENDO-02, physician)
Optimize resource utilization	Clustered: +18.8% vs non-clustered +5.7% (p < 0.001).	*"I use Sehat to book and follow-up; it saves time."* (C2-ENDO-04, patient) *"We still rely on paper files; sometimes families must bring records from home at midnight."* (SP-NC2-ONC-04, physician)
Reduce cost per patient	Clustered: –22.9% vs non-clustered –7.1% (p < 0.001).	*"Digital access and better coordination reduce unnecessary visits."* (SP-C2-ADMIN-03, physician)
Understand regional effects	Region effect non-significant in regression (p = 0.144).	*"During Hajj, everything slows down again despite clustering."* (SP-C1-ADMIN-03, physician) *"Here in the Eastern Province, IT systems help us keep things efficient."* (SP-C2-ENDO-05, physician)

factors such as pilgrimage surges in Mecca and stronger digital infrastructure in the Eastern Province Table 9.

DISCUSSION

This study provides evidence that hospital clustering within Saudi Arabia's SHSTP is associated with substantial improvements in patient satisfaction, staff efficiency, waiting times, and cost reduction compared to non-clustered facilities. These effects were most pronounced in the later reform phase (2021–2024), when digital health and governance structures were more firmly embedded. The consistency of these findings across multiple outcomes supports the effectiveness of clustering as a reform strategy and offers empirical validation for one of the cornerstones of Vision 2030[24].

International comparisons reinforce these observations. Studies in the United States demonstrate that multihospital systems achieve greater service integration and coordination, contributing to improved performance indicators[25]. Canadian reforms similarly show that clustering standardizes protocols and enhances outcomes[26], while the UK's NHS has reported efficiency gains and reductions in fragmented care through regional grouping of hospitals[27]. However, the present study adds context by demonstrating that such benefits are also achievable in a Middle Eastern health system undergoing rapid transformation, despite unique demographic and geographic pressures.

Digital health emerged as a critical enabler of improved outcomes. Clustered hospitals adopting EMRs, telemedicine, and patient-facing applications reported sharper gains in efficiency and patient satisfaction than non-clustered hospitals with limited IT systems[28]. This aligns with earlier evidence that digital platforms reduce administrative duplication, enhance coordination, and improve patient engagement[29]. In Saudi Arabia, recent investments in digital infrastructure and e-health solutions appear to have amplified the effects of clustering by enabling smoother communication across facilities[30].

Regional analysis highlighted important contextual differences. Although regression analyses found no statistically significant regional effect, qualitative interviews revealed that Mecca hospitals face unique surges during pilgrimage periods, straining capacity and undermining some benefits of clustering. By contrast, Eastern Province hospitals benefit from relatively stable patient populations and advanced IT infrastructure, supported in part by ARAMCO's contributions to healthcare development[31]. This suggests that while clustering provides broad benefits, localized policy adaptations are essential, such as additional surge capacity funding for Mecca during Hajj seasons and expanded digitalization efforts in regions with weaker infrastructure[31].

At the same time, some literature has cautioned against overgeneralizing clustering benefits. Gettel et al. found that integration does not consistently translate to higher quality[32], while Trilliant Health noted that benchmarking against mismatched peers may lead to misleading conclusions[33]. These insights underscore the need for careful performance monitoring, use of standardized indicators, and context-sensitive evaluation frameworks when assessing clustering outcomes.

This study has several limitations. First, although the quantitative dataset spanned 80 hospital-period observations, the analysis was restricted to four hospitals in two regions, which may limit generalizability. Second, qualitative data were based on purposive samples of patients and physicians, which may not capture all perspectives. Third, although rigorous steps were taken to validate findings, residual confounding cannot be ruled out. Despite these limitations, the integration of quantitative and qualitative strands strengthens confidence in the robustness of the conclusions.

Policy implications are clear. Scaling clustering reforms nationally should be prioritized, accompanied by sustained investment in digital health infrastructure, workforce training, and localized strategies for regions with unique pressures. Monitoring frameworks should include both quantitative KPIs and patient/physician feedback to ensure reforms remain responsive to the population's needs.

CONCLUSION

In conclusion, this study demonstrates that clustering under the SHSTP has delivered measurable improvements in healthcare performance in Saudi Arabia, particularly when supported by digital health adoption and contextualized governance. These findings contribute to the evidence base guiding Vision 2030 and underscore clustering as a viable strategy for achieving more integrated, efficient, and patient-centered care.

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