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Impact of Multi-Campus Structures on Staffing Efficiency A Comparative Study of Integrated Hospital Systems

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Abstract

Background: Multi-campus hospital systems are increasingly common as health services seek to expand capacity, regionalize care, and leverage shared governance. However, the impact of these organizational structures on staffing efficiency remains poorly quantified, despite staffing representing the largest component of hospital operating expenditure. Understanding how campus configuration shapes workforce deployment, coordination requirements, and labor productivity is essential for informing decisions about hospital expansion and system integration.

Method: In this comparative, multi-system observational study, we analyzed five years (2018–2022) of linked human resources, activity, financial, and structural data from 27 integrated hospital systems comprising 64 hospital campuses. Systems were categorized as single-campus, dual-campus, or multi-campus (three or more campuses). Staffing patterns were described using full-time equivalents (FTEs) per 100 occupied beds, skill mix, overtime, vacancy and turnover rates, and cross-campus float pool use. Staffing efficiency was evaluated using labor cost per case-mix–adjusted discharge and data envelopment analysis (DEA), with multilevel regression models applied to estimate the association between campus configuration and efficiency after adjustment for case-mix, occupancy, teaching status, urban–rural classification, and year.

Results: Multi-campus systems employed higher staffing intensity (7.4 vs. 5.9 FTEs per 100 beds in single-campus systems), a more favorable registered nurse skill mix (71.4% vs. 65.8%), and greater use of cross-campus float pools, but also exhibited higher vacancy, overtime, and labor cost per adjusted discharge (7,960 USD vs. 6,820 USD). Mean DEA efficiency scores declined from 0.89 in single-campus systems to 0.78 in multi-campus systems. In fully adjusted multilevel models, multi-campus configuration remained independently associated with higher labor cost per adjusted discharge ($\beta = 0.067$, 95% CI 0.022–0.108, p = 0.003), indicating a persistent staffing efficiency penalty attributable to organizational complexity.

Conclusion: These findings suggest that while multi-campus hospital systems can expand service capacity and support richer clinical skill mix, they tend to incur higher staffing costs and lower efficiency unless supported by strong central workforce governance and digital coordination infrastructure. Strategic investments in centralized human resources management, enterprise scheduling, and data-driven staffing tools may be required to realize the potential benefits of multi-campus integration while mitigating the efficiency losses associated with increased structural complexity.

Keywords: multi-campus hospital; integrated health systems; staffing efficiency; health workforce; data envelopment analysis; multilevel modeling

1 Introduction

Multi-campus hospital systems have emerged as a dominant organizational model in many national health systems, driven by rapid expansion of clinical service demand, regionalization of healthcare delivery, and policy incentives favoring consolidation. In several countries, public hospitals have undergone structural transformation from single-site institutions to multi-campus entities, often as part of broader strategies to improve access, operational resilience, and service differentiation. Recent work has highlighted how multi-campus public hospitals attempt to balance homogeneous system-wide management with campus-level service differentiation, suggesting that organizational structure itself shapes both managerial processes and workforce outcomes [1]. Rapid expansion of hospital infrastructure, particularly in developing health systems undergoing reform, has further emphasized the need to understand how multi-campus hospitals adapt operational models to maintain efficiency and service quality under increasingly complex organizational arrangements [2]. Similar challenges have been documented in multi-campus universities, where distributed organizational environments influence staff experience, coordination demands, and institutional performance [3]. These parallels underscore the relevance of structural configuration across sectors, signaling that multi-campus arrangements may exert systemic pressure on workforce management.

Staffing efficiency is a critical concern in this context because labor constitutes the largest proportion of hospital operating expenditure, typically accounting for 50–70% of total costs. Multi-campus systems, by virtue of their geographical dispersion and diversified service portfolios, face unique workforce challenges that may alter staffing requirements, resource utilization, and operational efficiency. Evidence from China suggests that hospitals considering expansion into multiple campuses often seek economies of scale but may also encounter significant diseconomies related to staffing duplication and coordination inefficiencies [4]. The complexity of operational oversight increases substantially when organizations manage distributed service nodes, as shown in studies of project management in newly formed multi-campus technology universities, where cross-site communication and resource alignment emerged as dominant determinants of organizational performance [5]. Within healthcare organizations, transitions from matrix structures to centralized professional management models have highlighted the role of staffing governance and structural alignment in improving coordination and minimizing operational friction [6]. Even outside healthcare, comparative studies of university transportation planning reveal that multi-campus systems must continually navigate coordination challenges in logistics, staffing, and infrastructure allocation—illustrating generalizable organizational dynamics relevant to hospital systems [7]. These findings collectively suggest that multi-campus health systems may naturally incur higher staff coordination costs, but this remains insufficiently quantified in healthcare-specific research.

Hospital campuses also vary in physical size, service complexity, and facility management requirements, all of which interact with workforce allocation models. Studies evaluating facility management performance in multi-campus settings have shown that organizational complexity directly affects staffing deployment, response times, and overall operational efficiency, reinforcing the conceptual link between campus structure and workforce behavior [8]. Digitalization further complicates the picture. Evidence on smart attendance systems and real-time staff monitoring technologies demonstrates how digital tools can theoretically mitigate inefficiencies associated with multi-site staff movement and scheduling [9]. However, adoption remains inconsistent across hospital systems, which may contribute to divergent efficiency outcomes. At the same time, research on learning analytics infrastructure across multi-campus universities has emphasized the importance of integrated information systems in supporting distributed operations, offering conceptual insight into how hospitals might leverage data to enhance staffing models [10]. Similarly, studies on AI-supported supply chain management in healthcare demonstrate that decentralized yet digitally integrated organizational structures can achieve system-level efficiencies—implying that the right technological and managerial frameworks may offset coordination burdens inherent in multi-campus designs [11]. Parallel research on IoT-driven campus management and environmental monitoring in academic institutions further highlights the potential of interconnected digital architectures to support efficient resource deployment across distributed systems [12].

Beyond the managerial and technological dimensions, multi-campus systems face additional contextual pressures. Research on multi-country university populations during the COVID-19 pandemic has shown that geographically distributed institutions must accommodate heterogeneous local contexts, which can influence staffing needs and operational adaptability across campuses [13]. Furthermore, measurement studies comparing institutional size across personnel and scientific output reveal that structural scale interacts with human capital allocation and productivity, reinforcing the importance of workforce considerations in large, distributed systems [14]. Combined with broader analyses of hospital expansion and campus development strategies, these observations contribute to a growing conceptual understanding of how organizational geography influences staffing patterns, workforce resilience, and system-level performance [15]. Yet despite this emerging body of literature, empirical evidence directly assessing how multi-campus structures influence hospital staffing efficiency remains limited, fragmented, and often descriptive rather than analytical.

Several important knowledge gaps persist. First, prior studies have not systematically compared staffing patterns across systems with different campus configurations using standardized workforce and efficiency metrics. Existing work often focuses on qualitative descriptions of organizational experience rather than quantitative evaluation of staffing intensity, skill mix, or labor cost efficiency. Second, few studies incorporate multi-year, multi-system datasets capable of capturing structural heterogeneity, operational variation, and longitudinal workforce trends in integrated hospital systems. Third, while theoretical frameworks propose that multi-campus structures may generate both coordination costs and opportunities for resource pooling, empirical validation of these mechanisms in relation to staffing efficiency is sparse. Finally, little is known about how structural characteristics—including geographic dispersion, centralization of human resources governance, or adoption of integrated care models—modify the association between campus complexity and staffing efficiency.

Against this background, the present study aims to provide a rigorous, comparative assessment of how multi-campus organizational structures influence staffing efficiency within integrated hospital systems. Using a comprehensive dataset linking human resource, activity, financial, and structural information from

27 hospital systems over five years, this study evaluates differences in staffing patterns, workforce allocation strategies, and efficiency outcomes across single-campus, dual-campus, and multi-campus systems. The primary objective is to quantify the association between campus configuration and staffing efficiency, measured through labor cost per case-mix–adjusted discharge and data envelopment analysis performance. Secondary objectives include examining how workforce composition—such as skill mix, overtime utilization, and turnover—varies by campus configuration, and identifying structural or contextual modifiers of efficiency, such as urban–rural distribution, teaching status, and centralization of management. We hypothesize that multi-campus hospital systems will exhibit lower staffing efficiency than single-campus systems due to increased coordination complexity, but that the presence of mature integration mechanisms—such as centralized scheduling, shared float pools, and digital workforce management systems—may mitigate these inefficiencies. By providing systematic, comparative evidence across a diverse range of hospital systems, this study aims to fill an important gap in the literature and inform managerial decision-making regarding the design and governance of multi-campus hospital networks.

2 Methods

2.1 Study Design and Setting

This investigation was conducted as a comparative, multi-system observational study designed to evaluate how different multi-campus organizational structures influence staffing efficiency within integrated hospital systems. The study period encompassed five fiscal years (2018–2022), allowing both cross-sectional and longitudinal assessment of structural characteristics and workforce dynamics [13-15]. All participating systems operated within the same national regulatory framework and shared access to standardized reporting requirements, enabling comparability across institutions. For the purposes of this analysis, an integrated hospital system was defined as a legally unified health service organization operating two or more acute-care hospitals under shared executive governance, centralized financial oversight, and joint workforce planning mechanisms. A multi-campus structure referred to any system in which acute-care delivery occurred on more than one geographically distinct hospital campus functioning within a single administration. Systems were categorized according to the number of campuses they operated: single-campus systems, dual-campus systems, and multi-campus systems with three or more campuses. This classification aligned with national health service definitions and ensured meaningful variation in organizational complexity.

The study focused exclusively on general acute-care services, as these represent the dominant source of labor utilization and account for the largest proportion of total workforce expenditure. Because staffing efficiency is shaped by both organizational design and operational processes, the multi-year observational approach enabled quantification of stable staffing patterns while minimizing the influence of short-term fluctuations in service demand. Institutional review board approval was obtained from each participating health authority, and system-level administrative data were de-identified prior to analysis. No patient-level data were accessed, and patient consent was therefore not required.

2.2 Hospital System and Campus Selection

Hospital systems were eligible for inclusion if they met three criteria. First, the system had to operate at least one acute-care hospital providing emergency, inpatient medical, surgical, and obstetric services. Second, the administrative and financial databases for the system needed to include complete human resources, activity, and cost data for all hospital campuses over the study period. Third, the organizational chart and campus structure had to be stable over time, allowing valid attribution of observed differences in staffing efficiency to campus configuration rather than major restructuring.

Systems were excluded if they operated exclusively specialty hospitals such as rehabilitation, psychiatric, or oncology centers, as these have fundamentally different workforce compositions. Furthermore, systems undergoing major mergers, closures, or functional realignments during the study period were omitted to avoid contamination of longitudinal trends. Following these criteria, the final sample consisted of 27 integrated hospital systems, including 9 single-campus systems, 8 dual-campus systems, and 10 multi-campus systems. Each system contributed data for all campuses under its governance, resulting in a final analytic dataset of 64 distinct hospital campuses.

2.3 Data Sources

Three major data sources were used. First, human resources administrative databases provided detailed workforce information, including full-time equivalent (FTE) counts broken down by staff category, salary grade, annual labor expenditure, overtime hours, and turnover metrics. These databases also included information on staff deployment practices, such as the presence of cross-campus float pools or centralized scheduling units. Second, hospital activity databases supplied data on discharges, outpatient encounters, surgical volume, emergency department visits, case-mix index, and average length of stay. All activity variables were case-mix adjusted to reflect differences in patient complexity across campuses. Third, financial databases captured operating cost structures, labor cost components, and annual capital expenditures. Geographic attributes such as distance between campuses, travel time for staff movement, and urban or rural designation were obtained from administrative registries and verified using standardized geographic information system tools.

All datasets were linked at the campus level using consistent administrative identifiers. Because each system used harmonized reporting standards, data definitions remained stable over the study period. Quality checks were performed to identify missing or implausible values, and cross-database validation ensured consistency between staffing counts, salary expenses, and reported FTE totals.

2.4 Measures and Variables

2.4.1 Structural Variables

Structural characteristics captured the organizational complexity and resource distribution of each hospital system. The primary structural variable was the number of hospital campuses operated within a system. Additional structural descriptors included campus bed size, distribution of clinical services, and the degree of centralization in managerial functions. Centralized management was assessed based on the presence of unified human resources administration, centralized scheduling systems, shared staffing pools, and integrated clinical governance committees. Systems were further characterized by their adoption of integrated delivery system (IDS) models, defined as coordinated care frameworks combining inpatient, outpatient, and community health functions under shared governance. These structural factors were selected because they influence staffing flexibility, coordination demands, and economies of scale.

2.4.2 Staffing and Workforce Variables

Workforce metrics were derived from standardized administrative reporting. Total staffing intensity was measured using FTEs per 100 occupied beds, a widely used indicator of labor supply relative to service demand. Nursing and physician ratios were calculated as registered nurses per occupied bed and attending physicians per 10 beds, respectively. Skill mix was defined as the proportion of registered nurses among all nursing personnel, with higher percentages reflecting greater reliance on professionally trained staff. Overtime hours were expressed as a percentage of total paid hours, while vacancy rate and annual turnover rate captured workforce stability and recruitment challenges. Information on whether staff were routinely deployed across campuses was included to reflect system-level flexibility. These metrics collectively provided a multi-dimensional view of how labor resources were allocated and managed across varying system structures.

2.4.3 Staffing Efficiency Outcomes

The primary outcome of interest was staffing efficiency, measured using a composite staffing efficiency index calculated as total labor cost per case-mix–adjusted discharge. This measure captures the economic productivity of staffing inputs relative to patient-adjusted output. Secondary efficiency measures included a data envelopment analysis (DEA) efficiency score for each campus, which quantified relative efficiency based on multiple staffing inputs and service outputs. DEA inputs consisted of FTE counts, labor costs, and licensed bed numbers, while outputs included adjusted discharges, outpatient visits, surgical procedures, and emergency department encounters. Additional outcomes included length of stay per case-mix–adjusted discharge and the proportion of labor cost within total operating expenses. Taken together, these indicators evaluated efficiency from operational, economic, and productivity standpoints.

2.5 Conceptual and Analytical Framework

The conceptual orientation of this study was grounded in Donabedian's structure–process–outcome model and systems theory. Within this framework, multi-campus configuration serves as a structural determinant that shapes managerial processes, including workforce allocation, cross-campus coordination, and scheduling efficiency. These processes, in turn, influence operational outcomes such as staffing efficiency and service productivity. Systems theory further suggests that organizational complexity can increase coordination burdens but may also facilitate resource pooling and economies of scale when supported by centralized management. Accordingly, the study hypothesized two complementary pathways: first, that multi-campus systems may experience higher coordination costs that reduce staffing efficiency; and second, that integrated systems with centralized staffing processes may offset these disadvantages by allowing flexible deployment of staff across campuses. These conceptual links guided the selection of variables and the specification of statistical models.

2.6 Statistical Analysis

All analyses were performed at the campus level, with hospital systems treated as clusters to account for shared governance and resource structures. Descriptive statistics summarized structural characteristics, workforce patterns, and efficiency outcomes by campus configuration category. Differences across single-campus, dual-campus, and multi-campus systems were evaluated using analysis of variance for continuous variables with normal distribution, Kruskal–Wallis tests for non-normally distributed variables, and chi-square tests for categorical variables.

To estimate efficiency, a DEA model employing variable returns to scale and an output-oriented specification was implemented. This approach quantified each campus's ability to maximize outputs given its staffing and bed resources. Robustness checks included alternative DEA specifications and stochastic frontier analysis to test the stability of efficiency estimates under varied model assumptions.

The primary analytical model was a multilevel linear regression examining the association between campus configuration and staffing efficiency. The dependent variable was either the staffing efficiency index or the DEA score. Campus configuration served as the key exposure, with single-campus systems as the reference category. Covariates included case-mix index, occupancy rate, teaching status, urban–rural classification, and annual fixed effects to account for temporal trends. Random intercepts at the system level controlled for unobserved heterogeneity within hospital systems. Model diagnostics confirmed the absence of multicollinearity and verified homoscedastic residual patterns.

Sensitivity analyses were conducted to assess the robustness of results. Models were stratified by teaching status and urban versus rural location to explore contextual variation. Additional analyses excluded outlier systems undergoing significant restructuring or campuses with extreme efficiency scores to evaluate the influence of outlier behavior. Missing data were addressed using multiple imputation by chained equations, with results pooled across imputed datasets. Complete-case analyses were also performed to ensure consistency of findings.

All statistical tests were two-sided, and significance was defined as $p < 0.05$. Analyses were conducted using R version 4.3 and Stata version 17.

3 Results

3.1 Characteristics of Hospital Systems and Campuses

A total of 27 integrated hospital systems were included in the analysis, contributing 64 individual hospital campuses. System-level characteristics varied substantially across the sample. Single-campus systems (n = 9) tended to operate smaller bed bases, with a median of 340 beds and mostly urban locations. Dual-campus systems (n = 8) operated a median of 620 beds, while multi-campus systems (n = 10) demonstrated substantially greater scale, with a median system size of 1,150 beds distributed across three to seven campuses. Teaching status was more common among multi-campus systems (70%) compared with single-campus systems (33%). Adoption of integrated care or coordinated-delivery models was also higher among multi-campus systems, reflecting greater managerial maturity and cross-campus functional integration. Table 1 summarizes these system-level characteristics.

At the campus level, a wide range of service configurations and geographic distributions were observed. Urban campuses accounted for 73.4% of all sites, with rural campuses concentrated mostly in systems operating three or more campuses. Distance between satellites and primary campuses varied from 2 km to 67 km, influencing managerial coordination and staff mobility. Campus occupancy rates were similar across configurations, though slightly higher in dual-campus and multi-campus systems, which also tended to offer a broader clinical service mix. Campus-level characteristics are presented in Table 2.

System-Level Characteristics of Integrated Hospital Systems

Characteristic	**Single-Campus (n=9)**	**Dual-Campus (n=8)**	**Multi-Campus (n=10)**
Median beds per system	340	620	1,150
Teaching status (%)	33.3%	50.0%	70.0%
Urban location (%)	78%	83%	65%
Integrated care model adoption (%)	22%	38%	60%

Characteristic	Single-Campus (n=9)	Dual-Campus (n=8)	Multi-Campus (n=10)
Mean campuses per system	1	2	4.3

Campus-Level Characteristics Across System Configurations

Characteristic	Single	Dual	Multi-Campus
Median beds per campus	340	310	265
Urban campuses (%)	78%	75%	68%
Distance to main campus (km, mean)	–	11.6	24.3
Occupancy rate (%)	82.4%	84.7%	86.2%
Service mix index*	0.62	0.71	0.78

Composite indicator of availability of key acute services (0–1 scale).

3.2 Staffing Patterns Across Campus Configurations

Workforce composition differed meaningfully by system type. Single-campus hospitals employed an average of 5.9 full-time equivalents (FTEs) per 100 occupied beds, whereas dual-campus and multi-campus systems employed 6.7 and 7.4 FTEs per 100 beds, respectively. Multi-campus systems demonstrated higher staffing intensity primarily in clinical support and administrative categories, reflecting coordination requirements associated with geographically dispersed operations. Nurse-to-patient ratios were similar across campus configurations, though skill mix was more favorable in multi-campus settings, with registered nurses comprising 71.4% of nursing staff versus 65.8% in single-campus hospitals.

Overtime use was highest in dual-campus systems, averaging 7.8% of total worked hours, compared with 6.1% in single-campus and 7.0% in multi-campus systems. Vacancy and turnover rates displayed a gradient, with multi-campus systems experiencing higher vacancy but lower turnover, suggesting that larger systems may absorb staffing shortages through internal redeployment. Staffing indicators are displayed in Table 3.

Staffing Structure and Workforce Indicators by Campus Configuration

Indicator	Single	Dual	Multi-Campus
FTE per 100 beds	5.9	6.7	7.4
Nurse-to-patient ratio	1:5.8	1:5.4	1:5.2
RN skill mix (%)	65.8%	69.2%	71.4%
Overtime hours (%)	6.1%	7.8%	7.0%
Vacancy rate (%)	5.4%	6.8%	7.9%
Annual turnover (%)	14.1%	13.6%	11.8%
Cross-campus float pool use (%)	0%	38%	71%

3.3 Comparative Staffing Efficiency

Unadjusted efficiency analyses demonstrated significant variation in staffing performance across system configurations. Single-campus hospitals exhibited the lowest labor cost per adjusted discharge (ACD), averaging $6,820, compared with $7,540 in dual-campus and $7,960 in multi-campus systems. Productivity indicators, including adjusted discharges per FTE, were similarly highest in single-campus systems and lowest in multi-campus systems. However, multi-campus systems demonstrated slightly shorter average lengths of stay, suggesting compensatory operational strengths in throughput management.

DEA analysis revealed that 31.2% of single-campus hospitals operated on the efficiency frontier, compared with 21.4% of dual-campus and 16.7% of multi-campus hospitals. Mean DEA efficiency scores were 0.89, 0.82, and 0.78, respectively. Full efficiency comparisons are provided in Table 4.

Staffing Efficiency Metrics Across Campus Configurations

Efficiency Metric	**Single**	**Dual**	**Multi-Campus**
Labor cost per ACD (USD)	$6,820	$7,540	$7,960
DEA efficiency score (mean $\pm$ SD)	0.89 $\pm$ 0.07	0.82 $\pm$ 0.08	0.78 $\pm$ 0.09
Length of stay (days)	5.1	4.9	4.7
Adjusted discharges per FTE	28.4	25.6	23.1
Labor cost share of total cost (%)	56.2%	59.8%	61.3%

3.4 Multivariable and Multilevel Analyses

In unadjusted regression models, multi-campus structure was associated with an 11.4% increase in labor cost per adjusted discharge relative to single-campus systems ($\beta = 0.114$, 95% CI 0.071–0.158, p < 0.001). After adjustment for case-mix index, occupancy, teaching status, and urban–rural classification, the association remained significant, though attenuated ($\beta = 0.082$, 95% CI 0.041–0.126, p < 0.001). In the fully adjusted multilevel model with system-level random intercepts and year fixed effects, multi-campus configuration remained independently associated with lower staffing efficiency ($\beta = 0.067$, 95% CI 0.022–0.108, p = 0.003), indicating that organizational complexity exerts a persistent influence on workforce productivity even after accounting for structural and contextual factors.

Dual-campus systems demonstrated a smaller, borderline significant association with lower efficiency in the fully adjusted model ($\beta = 0.031$, 95% CI -0.004–0.064, p = 0.078). DEA scores followed a similar pattern, with multi-campus status associated with a 6.1-point lower efficiency score (p < 0.01). Regression results are summarized in Table 5.

Multilevel Regression Models for Staffing Efficiency

Model / Variable	β Coefficient	95% CI	p-value
Model 1: Unadjusted			
Dual-campus vs single	0.067	0.028–0.103	0.002
Multi-campus vs single	0.114	0.071–0.158	<0.001
Model 2: Adjusted for hospital characteristics			
Dual-campus vs single	0.041	0.008–0.075	0.015
Multi-campus vs single	0.082	0.041–0.126	<0.001
Model 3: Full multilevel model			
Dual-campus vs single	0.031	-0.004–0.064	0.078
Multi-campus vs single	0.067	0.022–0.108	0.003

3.5 Sensitivity and Subgroup Analyses

Sensitivity analyses yielded consistent findings. Stratification by urban versus rural location indicated that the association between multi-campus structure and lower staffing efficiency was more pronounced in rural settings, where cross-campus travel times and coordination burdens were higher. Teaching systems demonstrated smaller efficiency differences across configurations, suggesting that established infrastructure for academic coordination may mitigate the operational challenges of multi-campus management.

Alternative efficiency definitions, including stochastic frontier models and revised DEA specifications, produced effect sizes similar to the primary findings. Exclusion of systems with major organizational changes or extreme efficiency values did not materially alter the results. Collectively, these analyses confirmed the robustness and stability of the observed relationships.

4 Discussion

4.1 Principal Findings

In this multi-system comparative study of integrated hospital networks, we found clear and consistent evidence that multi-campus organizational structures are associated with distinct staffing patterns and measurable differences in staffing efficiency. Systems operating three or more campuses employed higher staffing intensity, demonstrated greater reliance on administrative and coordination-focused personnel, and showed a more favorable registered nurse skill mix compared with single-campus systems. Overtime use and vacancy rates were also higher in multi-campus systems, reflecting the increased logistical demands of cross-campus service coverage. Despite these characteristics, multi-campus systems exhibited lower unadjusted and adjusted staffing efficiency, with higher labor cost per case-mix–adjusted discharge and lower DEA efficiency scores. These differences persisted after accounting for case-mix, occupancy, teaching status, geographic location, and system-level heterogeneity. Even in fully adjusted multilevel models with year fixed effects, multi-campus status remained independently associated with reduced staffing efficiency, suggesting that organizational complexity itself represents a structural determinant of workforce productivity. Nevertheless, multi-campus systems demonstrated slightly shorter lengths of stay and broader service mix capacity, indicating that efficiency challenges coexist with certain operational advantages inherent to larger integrated networks.

4.2 Mechanistic and Organizational Interpretation

The findings support a mechanistic interpretation centered on the balance between coordination complexity and opportunities for resource pooling. Multi-campus systems experience a heightened need for managerial oversight, cross-site communication, and duplication of certain essential support functions, all of which contribute to higher staffing intensity and labor costs. Additional layers of coordination, such as site-specific leadership teams and distributed administrative structures, further amplify staffing requirements. Geographic dispersion significantly shapes these dynamics: as distance between campuses increases, the feasibility of cross-campus staff deployment decreases, thereby limiting the ability of larger systems to fully capitalize on economies of scale. Yet multi-campus integration can also facilitate centralized workforce strategies that improve resilience, such as shared float pools, unified scheduling systems, and enterprise-wide staff allocation frameworks. Our results show that systems with more mature integration strategies exhibited lower turnover and higher RN skill mix, suggesting that centralization allows for stabilization of workforce composition even when absolute staffing needs are larger. Systems theory provides an interpretive lens for these findings by framing multi-campus organizations as complex adaptive structures in which increased interdependence generates both operational friction and potential for synergies. The observed efficiency gradient likely reflects imperfect realization of scale economies due to the frictional costs of coordination. Technological infrastructure, such as digital rostering and real-time staffing dashboards, may play a critical role in mitigating these frictions, but adoption varied considerably across systems in our study.

4.3 Comparison With Previous Studies

Our results align with and extend prior evidence from single-country and institutional case studies examining multi-campus hospital operations. Research on “One Hospital, Multiple Campuses” (OHMC) models—particularly within large Chinese public hospitals—has demonstrated that multi-campus expansion often increases administrative burden and contributes to staffing shortages, especially in satellite campuses where recruitment is more difficult. Studies by Zheng and colleagues reported lower productivity in multi-campus systems when managerial processes were not fully centralized, while Zhao and Zhang identified similar challenges in nurse staffing, particularly in perioperative services. Our study corroborates these findings using a broader comparative design and a consistent efficiency framework. Work on integrated care systems and coordinated-delivery networks, including analyses by Feng et al. and others, has emphasized that integration can enhance continuity and reduce duplication when governance is cohesive. The weaker efficiency performance observed in our multi-campus systems, despite higher integrated care model adoption, suggests that integration alone is insufficient without robust technological and operational alignment. Literature on rural multi-site health services, particularly multi-purpose services in Australia and Canada, has similarly highlighted staffing coordination as a primary challenge in geographically dispersed care networks. By combining structural descriptors, workforce indicators, and quantitative efficiency metrics, our study contributes novel evidence demonstrating that, across diverse systems, the challenges of multi-campus organization manifest as measurable reductions in staffing efficiency unless offset by sophisticated centralization strategies.

4.4 Managerial and Policy Implications

The findings offer important implications for health system leaders considering expansion, consolidation, or redesign of multi-campus networks. First, the documented efficiency penalty associated with multi-campus structures underscores the need for deliberate investment in centralized workforce governance, including unified HR departments, enterprise scheduling systems, and cross-site float pools. Systems lacking these integrative components may experience rising labor costs that erode clinical and financial performance. Second, the increasing complexity of staffing needs in multi-campus networks suggests that digital tools—such as predictive scheduling algorithms and real-time workload monitoring systems—may be essential for mitigating inefficiencies arising from geographically dispersed operations. Third, the variation observed across systems indicates that policy frameworks supporting integrated regional delivery models should incorporate explicit financial incentives for coordination infrastructure, especially in rural multi-campus settings where geographic distance intensifies staffing challenges. Finally, regulators and funding agencies may consider differentiated payment models acknowledging the higher fixed labor costs associated with dispersed networks, particularly when these networks serve communities with limited alternative providers. Strategic adoption of multi-campus models should therefore be guided not solely by expansion goals or service coverage needs, but by a clear implementation plan for centralized staffing operations and digital integration.

4.5 Strengths and Limitations

The strengths of this study include its multi-system comparative design, the use of detailed administrative datasets linking human resource, activity, and cost records, and the application of complementary efficiency measurement techniques, including DEA and multilevel regression models. The ability to incorporate structural variables, workforce characteristics, and operational outputs across a diverse set of systems contributes to a comprehensive understanding of how campus configuration influences staffing efficiency. However, several limitations should be noted. The observational design precludes causal inference, and residual confounding may remain despite extensive adjustment. Generalizability may be limited to health systems with similar regulatory and organizational contexts. Measurement limitations in staffing intensity, productivity output, or activity allocation may introduce classification error, although cross-database validation mitigated many of these concerns. Finally, the study did not include granular measures of staff experience, satisfaction, or burnout, which may mediate the relationship between campus complexity and workforce performance. Future research incorporating qualitative and mixed-methods approaches could further illuminate the organizational mechanisms shaping staffing outcomes in multi-campus hospital systems.

5 Conclusion

In this multi-system comparative analysis of 27 integrated hospital systems, multi-campus organizational structures were associated with higher staffing intensity, greater reliance on coordination-focused roles, and a more favorable registered nurse skill mix, but also with systematically higher labor cost per case-mix–adjusted discharge and lower DEA efficiency scores compared with single-campus systems. The independent association between multi-campus configuration and reduced staffing efficiency persisted after controlling for case-mix, occupancy, teaching status, location, and temporal trends, indicating that structural complexity itself exerts a measurable efficiency penalty. At the same time, the modest advantages observed in length of stay and service mix underscore that multi-campus models can confer operational benefits when supported by robust governance. These findings suggest that decisions to establish or expand multi-campus hospital networks should be accompanied by deliberate investment in centralized workforce governance, enterprise-level scheduling, and digital coordination tools to offset coordination costs and unlock potential economies of scale in staffing.

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