Original Article

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Impact of COVID-19 on the Profitability of General Hospitals in Korea

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Objectives: This study was performed to quantify the impact of coronavirus disease 2019 (COVID-19) on hospital profitability in Korea by analyzing changes in the medical revenue-to-profit ratio (MRPR) and net income before reserve fund allocation (NIBR) before and after the pandemic onset. Additionally, it examined how financial outcomes varied by hospital ownership, geographic location, and type (secondary or tertiary), providing insights into the financial resilience of various hospital types during public health crises.

Methods: We conducted a longitudinal analysis using publicly available financial disclosure data from 243 general hospitals in Korea (2016–2022). We then performed a quadrant analysis to classify hospitals based on changes in MRPR and NIBR, identifying patterns of financial impact. For inferential analysis, we employed linear mixed-effects models incorporating a difference-in-differences framework, enabling estimation of both time-varying and hospital-specific effects.

Results: Following the onset of COVID-19, MRPR declined significantly, reaching −10.62% in 2020. NIBR initially dropped but later increased, reaching 21.09 billion Korean won per 100 beds in 2022. Quadrant analysis revealed substantial heterogeneity in financial responses, with national/public hospitals experiencing the most severe MRPR decline, whereas educational foundation and medical corporation hospitals displayed stronger financial recovery. Regression results confirmed significant interactions between outcomes after COVID-19 onset and hospital ownership type, indicating differential financial impacts across hospital categories.

Conclusions: The findings highlight the uneven financial effects of COVID-19 on Korean hospitals, emphasizing the importance of targeted government financial support. Policy measures should prioritize structural financial reforms to ensure hospital sustainability beyond short-term crisis management.

Key words: Organizational efficiency; Financial management; Hospital; COVID-19

INTRODUCTION

The coronavirus disease (COVID-19) pandemic profoundly affected healthcare systems worldwide, including in Korea [1,2]. As one of the first countries to experience large-scale community transmission, Korea responded swiftly with aggressive public health measures, including social distancing, contact tracing, and designated COVID-19 treatment facilities [3,4]. While these measures helped avert widespread collapse of the healthcare system, they also significantly altered healthcare utilization patterns and placed unprecedented burdens

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on hospitals [5,6].

During the pandemic, outpatient visits and elective procedures declined sharply, while hospitals faced increased operational costs due to infection control measures and emergency capacity expansion [7,8]. The Korean government provided substantial financial support, compensating hospitals for lost revenue, additional staffing, and supply costs [3]. However, despite these efforts, the financial impact varied widely across different types of hospitals, resulting in considerable financial hardship [9]. While some large tertiary hospitals recovered and later expanded operations [10], public hospitals and smaller institutions experienced worsening financial distress despite receiving government aid [11].

Using related data, we can identify which hospital characteristics are associated with financial vulnerability during public health crises [12]. This is especially important in Korea, where concerns about the sustainability of healthcare services are increasingly being discussed [13]. Although it is crucial to anticipate which hospitals are most at risk in future healthcare crises and to develop strategies for mitigation, limited research has explicitly analyzed how these effects vary based on hospital characteristics. Existing studies have primarily examined overall healthcare utilization patterns or focused on public hospitals, rather than assessing differential impacts across hospital categories [9,14,15]. Moreover, given the unique accounting practices of general hospitals in Korea, financial indicators must be chosen carefully, extending beyond surface-level metrics [16].

Given this gap, it is essential to quantitatively assess the differential financial impact of COVID-19 across various hospital attributes. Our primary research objectives were to (1) evaluate how hospital profitability changed after the onset of the COVID-19 pandemic and (2) identify which hospital attributes—among ownership type, geographic location, and classification (tertiary vs. general hospitals)—are associated with greater financial vulnerability during public health crises. In this study, we focus on 2 financial indicators, medical revenue-to-profit ratio (MRPR) and net income before reserve fund allocation (NIBR), as key measures of hospital profitability. We selected these indicators instead of more superficial metrics because they better reflect the core operational sustainability of hospitals in the Korean accounting context. Using longitudinal financial data from 2016 to 2022, this research aims to provide a comprehensive assessment of financial performance during the COVID-19 pandemic across hospital characteristics.

METHODS

Hospital Finance Data

This study used publicly available financial disclosure data from the Korea Health Industry Development Institute (KHIDI) for 2016–2022. We focused on this period to capture direct financial impacts during the active pandemic years rather than the subsequent recovery phase, enabling more precise identification of crisis-specific financial vulnerabilities. Hospitals eligible for inclusion were general or tertiary hospitals legally designated under the Korean Medical Service Act, excluding long-term care, psychiatric, dental, and specialized hospitals. Of the 379 hospitals identified in the KHIDI database, 130 were excluded due to missing financial disclosures in 1 or more years during the study period. Additionally, 6 hospitals that underwent institutional classification changes (that is, promotion or demotion between general and tertiary hospital status) were excluded. Hospitals with temporary or irregular data reporting, such as newly opened facilities or hospitals with intermittent closures, were also excluded to maintain temporal continuity. This resulted in a final sample of 243 general hospitals with complete financial data for all 7 consecutive years, supporting consistent longitudinal analysis (Supplement Material 1).

Outcome Variables (Hospital Profitability Metrics)

Two core financial indicators were selected to assess hospital profitability. MRPR was calculated as the proportion of medical profit to medical revenue, providing insight into operational efficiency and profitability derived directly from medical services. NIBR [17-21] was analyzed to capture overall financial health, normalizing values per 100 hospital beds to account for size differences [22,23]. Since hospitals in Korea allocate a portion of their income to statutory reserve funds, NIBR offers a clearer picture of financial performance before such allocations [24,25].

Logarithmic scales were applied to both financial metrics to accommodate the wide range of observed values. The average changes in MRPR (in percentage points [%p]) and NIBR per 100 beds (in billion Korean won [KRW]) were calculated by comparing pre-pandemic (2016–2019) and pandemic (2020–2022) periods. For visualization, hospital characteristics were distinguished by colors and marker shapes representing ownership type, classification status, and geographic location.

Independent Variables (Hospital Characteristics)

Hospitals were categorized by ownership type, geographic location, and size to explore heterogeneity in financial outcomes. Ownership types included national/public hospitals, social welfare or special foundation hospitals, medical corporations, educational foundations, and private hospitals. Geographic location was classified as the capital region (Seoul, Incheon, and Gyeonggi Province) or non-capital regions (all other areas). Hospital size was categorized by number of beds, with categories of <200, 200–499, 500–999, 1000–1999, and ≥ 2000 beds.

Covariates

Several hospital-level covariates were adjusted to ensure robust estimation of the effect of COVID-19. The year (2016–2022) was included as a key factor to account for trends in hospital profitability over time. The COVID-19 impact was operationalized as a categorical variable, in which pre-pandemic years (2016–2019) were coded as 0, while pandemic years received sequential values: 2020 (1), 2021 (2), and 2022 (3). This coding structure enabled evaluation of COVID-19 effects while accounting for underlying yearly trends. The proportion of medical residents among total physicians was incorporated as a measure of hospital structure, given its potential impact on costs. Due to data limitations, resident proportion values were taken from 2022 and applied consistently across all study years. Furthermore, hospitals were stratified by bed capacity to evaluate whether financial resilience differed significantly by hospital size.

Statistical Analysis

Summary statistics were computed for MRPR and NIBR across hospital categories to characterize overall trends. Changes in profitability before and after the onset of COVID-19 were visualized using quadrant analysis, which classified hospitals according to positive or negative changes in MRPR and NIBR.

A linear mixed-effects model was employed to assess the impact of COVID-19 on hospital profitability while accounting for within-hospital correlations over time. The base model (model 1) estimated the main effects of COVID-19 and hospital characteristics on MRPR and NIBR using the following structure:

$$y_{it} = \beta_0 + \beta_1 \cdot Year_t + \beta_2 \cdot COVID_t + \beta_3 \cdot Classification_i + \beta_4 \cdot Location_i + \beta_5 \cdot Ownership_i + \beta_6 \cdot Beds_{it} + \beta_7 \cdot Resident\ Ratio_i + u_i + \epsilon_t$$

Here, y_{it} represents the profitability measure (MRPR or NIBR) for hospital i in year t; COVID-19 period is a categorical variable coded as 0 for pre-pandemic years (2016–2019) and 1, 2, and 3 for 2020, 2021, and 2022, respectively; and u_i represents hospital-specific random effects.

In model 2, we used a difference-in-differences (DiD) approach within the linear mixed-effects framework to account for both fixed and random effects. Interaction analysis was conducted to identify which hospital characteristics were associated with the greatest financial vulnerability to COVID-19. Specifically, we assessed interactions between the COVID-19 term and hospital ownership, geographic region, and bed capacity:

$$y_{it} = \beta_0 + \beta_1 \cdot Year_t + \beta_2 \cdot COVID_t + \beta_3 \cdot Classification_i + \beta_4 \cdot Location_i + \beta_5 \cdot Ownership_i + \beta_6 \cdot COVID_t \cdot Classification_i + \beta_7 \cdot COVID_t \cdot Location_i + \beta_8 \cdot COVID_t \cdot Ownership_i + \beta_9 \cdot Beds_{it} + \beta_{10} \cdot Resident\ Ratio_i + u_i + \epsilon_t$$

This model structure allowed us to estimate heterogeneous treatment effects of the COVID-19 pandemic across hospital characteristics, a key feature of extended DiD designs. Our model incorporates multiple interaction terms with time-varying treatment levels and hospital-level covariates, enabling a more granular understanding of how financial outcomes evolved for different hospital types during the pandemic period.

Ethics Statement

As this study analyzed publicly accessible institutional financial reports and did not involve human participants or private health information, it was exempt from institutional review board approval.

RESULTS

Baseline Characteristics

The study analyzed 243 general hospitals in Korea with complete financial data from 2016 to 2022. Of these, 40 (16.5%) were tertiary hospitals, and 203 (83.5%) were general hospitals. By geographic distribution, 103 hospitals (42.4%) were in the capital region (Seoul, Incheon, and Gyeonggi Province), while 140 (57.6%) were elsewhere. Ownership types were as follows: 104 (42.8%) medical corporations, 58 (23.9%) national/public hospitals, 56 (23.0%) educational foundation hospitals, 19 (7.8%) special foundation hospitals, and 6 (2.5%) social

Table 1. Hospital characteristics by classification

Characteristics	Included			Excluded				*p*-value
	Tertiary	Secondary	Total (n)	Tertiary	Secondary	Other[1]	Total (n)	
Location								0.090
Capital region	21 (52.5)	82 (40.4)	103	1 (16.7)	28 (36.4)	16 (30.2)	45	
Non-capital region	19 (47.5)	121 (59.6)	140	5 (83.3)	49 (63.6)	37 (69.8)	91	
Ownership type								<0.001
National/Public	11 (27.5)	47 (23.2)	58	-	5 (6.5)	4 (7.5)	9	
Social welfare/Special foundation	1 (2.5)	5 (2.0)	6	1 (16.7)	3 (3.9)	2 (3.8)	6	
Medical	2 (5.0)	102 (50.2)	104	-	58 (75.3)	40 (75.5)	98	
Private	1 (2.5)	18 (8.9)	19	-	5 (6.5)	7 (13.2)	12	
Educational	25 (62.5)	31 (15.3)	56	5 (83.3)	6 (7.8)	-	11	
Bed capacity[2]								<0.010
<200	-	20 (9.9)	20	-	-	22 (41.5)	22	
200–499	-	138 (68.0)	138	-	19 (24.7)	31 (58.5)	50	
500–999	24 (60.0)	44 (21.7)	68	-	51 (66.2)	-	51	
1000–1999	13 (32.5)	1 (0.5)	14	6 (100)	7 (9.1)	-	13	
≥2000	3 (7.5)	-	3	-	-	-	0	
Proportion of resident physicians (%)[2]								<0.001
<10	-	147 (72.4)	147	-	62 (80.5)	53 (100)	115	
10–19	1 (2.5)	23 (11.3)	24	5 (83.3)	15 (19.5)	-	20	
20–29	7 (17.5)	20 (9.9)	27	1 (16.7)	-	-	1	
≥30	32 (80.0)	13 (6.4)	45	-	-	-	0	
Total	40 (100)	203 (100)	243	6 (100)	77 (100)	53 (100)	136	

Values are presented as number (%).
[1]Nursing hospital or psychiatric hospital.
[2]Based on 2022 data.

welfare hospitals. By bed capacity, 20 hospitals (8.2%) had fewer than 200 beds, 138 (56.8%) had 200–499 beds, 68 (28.0%) had 500–999 beds, 14 (5.8%) had 1000–1999 beds, and 3 (1.2%) had over 2000 beds. The proportion of resident physicians also varied: 147 hospitals (60.5%) had fewer than 10% residents, 24 (9.9%) had 10–20%, 27 (11.1%) had 20–30%, and 45 (18.5%) had over 30%.

Excluded hospitals differed markedly from those included. Most excluded facilities were psychiatric and nursing hospitals that appeared only in the 2022 dataset. These institutions were structurally distinct from the included general hospitals, as they typically lacked tertiary-level services, had smaller bed capacities, and almost universally reported fewer than 10% resident physicians. Accordingly, the final analytic sample reflects mid-sized to large general hospitals, which may limit the applicability of the findings to smaller or community-based institutions (Table 1).

Annual Trends in Medical Revenue-to-profit Ratio and Net Income Before Reserve Fund Allocation

Table 2 presents annual MRPR from 2016 to 2022 across hospital classifications. MRPR remained positive before the pandemic but became negative in 2020 across all groups. The most pronounced decline was observed for national/public hospitals (−39.64%), followed by hospitals with fewer than 200 beds (−21.31%) and those in the capital region (−14.34%). In contrast, medical corporations and educational foundation hospitals experienced relatively modest decreases and partial recovery in later years. The table also shows that hospitals with greater bed capacity maintained higher MRPR values than smaller hospitals throughout the study period.

Table 3 summarizes annual NIBR per 100 beds from 2016 to 2022. In 2020, NIBR decreased in all groups, with national/public hospitals (1.15 billion KRW) and small hospitals (<200 beds, −4.72 billion KRW) exhibiting the lowest values. However, a sharp increase was noted in 2021, primarily among national/public hospitals (53.71 billion KRW), followed by hospitals in

Table 2. Annual trends in medical revenue-to-profit ratio (%), 2016-2022

Subgroup	n	2016	2017	2018	2019	2020	2021	2022
Total	243	1.72±8.50	0.73±8.77	0.65±9.22	0.78±8.97	−10.62±27.78	−6.29±23.69	−9.45±32.24
Classification								
Tertiary	40	4.18±5.91	4.35±5.67	3.92±5.16	4.33±5.23	0.66±6.36	2.84±5.98	1.68±5.90
Secondary	203	1.24±8.85	0.01±9.10	0.01±9.70	0.08±9.38	−12.84±29.78	−8.08±25.41	−11.64±34.77
Location								
Capital region	103	1.19±9.63	0.00±9.48	−0.84±10.85	−0.15±10.37	−14.34±37.13	−7.27±28.38	−13.80±44.39
Non-capital region	140	2.12±7.58	1.26±8.20	1.75±7.66	1.47±7.75	−7.88±17.72	−5.56±19.62	−6.25±18.42
Ownership								
National/Public	58	−6.61±9.84	−8.35±10.02	−8.28±12.08	−8.57±10.88	−39.64±44.57	−29.52±31.63	−38.60±47.38
Social welfare/Special foundation	6	−2.13±5.65	−3.23±3.29	−2.29±3.98	−2.39±4.02	−7.81±6.37	−5.62±4.01	−7.22±7.48
Medical corporation	104	4.94±5.37	3.61±5.46	3.91±5.50	4.30±5.21	−1.12±7.36	0.98±18.25	0.05±22.89
Private foundation	19	1.40±5.25	0.97±5.53	1.10±5.03	1.63±4.59	−3.59±4.96	0.21±5.36	−0.09±5.98
Educational foundation	56	4.91±6.85	5.11±6.60	4.02±6.31	3.98±6.68	−0.90±7.14	2.01±6.66	−0.33±8.16
Bed capacity								
<200	20	−1.19±9.04	−3.49±10.75	−4.51±14.39	−3.82±12.05	−21.31±42.65	−13.40±24.38	−13.91±26.79
200–499	138	1.00±8.43	−0.21±8.85	0.28±9.10	0.16±9.12	−12.69±29.04	−8.42±27.80	−12.64±39.10
500–999	68	3.83±8.61	3.33±7.96	2.44±7.87	2.79±7.85	−5.90±21.12	−1.84±14.50	−4.18±18.28
1000–1999	14	2.71±6.79	3.11±5.26	2.84±4.51	3.79±4.71	−0.19±6.16	1.23±6.21	−0.27±6.57
≥2000	3	1.85±5.64	1.80±5.68	1.77±4.18	0.46±2.56	0.02±2.78	3.61±2.77	4.73±2.25
Proportion of resident physicians (%)								
<10	147	1.32±8.21	−0.31±9.03	0.03±9.59	0.15±9.19	−13.08±30.43	−8.19±26.67	−11.28±37.35
10–19	24	−0.19±7.02	−0.35±5.87	−0.71±6.32	−0.35±6.61	−14.03±28.45	−10.68±23.23	−17.29±29.62
20–29	27	2.19±10.04	2.85±9.13	1.38±11.07	1.12±11.59	−8.54±27.36	−3.39±21.40	−6.27±24.42
≥30	45	3.77±9.03	3.41±8.40	2.99±7.81	3.24±7.19	−2.02±14.20	0.54±9.92	−1.21±12.46

Values are presented as mean±standard deviation.

the capital region (37.93 billion KRW). This finding suggests a temporary financial recovery. Medical corporations and educational foundation hospitals showed steady increases in NIBR over time, whereas hospitals with fewer than 200 beds consistently reported lower NIBR than larger hospitals.

Quadrant Analysis of Profitability Changes

The quadrant analysis categorized hospitals based on concurrent changes in MRPR and NIBR after the onset of COVID-19 (Figure 1A). Of the 243 hospitals analyzed, 40 (16.5%) were classified into Quadrant 1, which was characterized by increases in both MRPR and NIBR; 101 (41.6%) fell into Quadrant 2, in which MRPR decreased but NIBR increased; 98 (40.3%) were assigned to Quadrant 3, where both measures declined; and 4 (1.6%) were categorized into Quadrant 4, where MRPR increased but NIBR decreased.

The distribution of hospitals across quadrants differed by ownership type, geographic location, and bed capacity (Figure 1B). National/public hospitals were primarily found in Quadrants 2 and 3, indicating declines in MRPR. Educational foundation hospitals clustered in Quadrant 1, with increased MRPR and NIBR values. Hospitals in the capital region displayed larger MRPR declines and greater NIBR increases than those in non-capital areas. Hospitals with fewer than 500 beds more frequently appeared in Quadrant 3, whereas those with 1000 or more beds were more often found in Quadrants 1 and 2.

Multivariate Analysis of the Financial Impact of Coronavirus Disease 2019

Mixed-effects regression results indicate that MRPR decreased by 1.33%p (95% CI, −2.07 to −0.59) per year over the study period. The COVID-19 period had an additional negative effect on MRPR (−1.55%p; 95% CI, −2.86 to −0.23) beyond the annual trend. Conversely, NIBR per 100 beds increased by 6.67 billion KRW (95% CI, 3.36 to 9.97) during the COVID-19 period, despite a non-significant annual trend.

In the interaction analysis, hospital characteristics showed

Table 3. Annual trends in net income before reserve fund allocation (billion KRW/100 beds), 2016-2022

Variables	n	2016	2017	2018	2019	2020	2021	2022
Total	243	8.55±14.17	7.37±14.94	7.87±14.28	8.90±16.64	2.56±17.11	25.39±80.87	21.09±48.47
Classification								
Tertiary	40	17.26±19.35	18.53±20.78	17.88±19.09	21.06±22.31	14.06±23.40	39.29±36.34	37.33±24.86
Secondary	203	6.83±12.26	5.17±12.43	5.90±12.25	6.51±14.17	0.29±14.62	22.65±86.80	17.89±51.31
Location								
Capital region	103	10.14±15.44	7.98±16.56	7.84±15.29	10.04±19.00	2.70±20.65	37.93±121.20	32.24±70.24
Non-capital region	140	7.37±13.09	6.92±13.67	7.89±13.55	8.06±14.68	2.45±14.02	16.16±20.11	12.89±17.61
Ownership								
National/Public	58	2.93±11.00	0.76±10.33	2.76±10.11	1.83±9.79	1.15±17.91	53.71±157.48	8.43±19.26
Social welfare/Special foundation	6	1.05±11.27	–3.72±14.06	0.37±8.79	0.81±9.46	–1.27±11.88	4.22±9.41	5.93±20.29
Medical corporation	104	7.56±10.57	6.04±10.90	6.53±11.12	8.92±13.90	0.99±13.76	14.19±23.92	30.85±67.90
Private foundation	19	6.73±10.97	6.08±10.65	7.59±10.49	8.29±11.02	–0.56±8.24	8.17±12.11	12.75±15.39
Educational foundation	56	17.61±19.29	18.3±20.22	16.55±20.07	17.26±24.05	8.40±22.79	24.96±26.68	20.56±28.40
Bed capacity								
<200	20	4.81±11.55	1.95±11.12	3.53±13.35	2.24±20.38	–4.72±16.93	15.34±29.83	2.09±17.01
200–499	138	4.99±9.31	3.35±10.19	5.16±10.11	5.46±10.93	0.76±14.01	17.23±24.97	23.37±60.20
500–999	68	15.50±17.73	15.10±17.86	13.06±18.38	16.03±21.00	6.50±19.66	41.04±145.17	18.28±25.54
1000–1999	14	12.65±19.43	15.07±18.71	12.53±15.28	15.96±20.45	6.74±23.75	39.25±50.83	30.47±23.58
≥2000	3	20.20±33.71	16.87±42.03	22.15±32.77	16.98±21.46	24.67±22.26	48.02±35.35	63.09±18.22
Proportion of resident physicians (%)								
<10	147	5.44±8.87	3.31±9.35	4.90±9.81	5.38±11.70	0.06±13.27	17.75±25.80	19.86±50.15
10–19	24	6.74±14.35	4.34±13.50	4.59±15.33	5.75±18.15	0.16±20.65	11.52±23.95	16.00±80.66
20–29	27	14.38±17.30	17.84±16.43	12.97±16.03	15.50±23.94	5.65±21.46	25.30±24.64	17.44±29.92
≥30	45	16.17±21.09	15.94±21.91	16.27±20.11	18.13±19.94	10.13±21.03	57.78±178.12	30.03±23.20

Values are presented as mean±standard deviation.
KRW, Korean won.

differential impacts during the COVID-19 period. Secondary hospitals experienced a 1.90%p reduction in MRPR relative to tertiary hospitals, although the difference between these groups was not statistically significant for NIBR. Non-capital region hospitals maintained MRPR values that were 4.16%p higher (95% CI, 1.28 to 7.04) than those of capital-region facilities during COVID-19.

By ownership type, medical corporation hospitals demonstrated the strongest positive MRPR effect (16.40%p; 95% CI, 12.80 to 20.00) compared with national/public hospitals, followed by educational foundation hospitals (13.77%p; 95% CI, 9.41 to 18.13) and private foundation hospitals (11.05%p; 95% CI, 5.36 to 16.74). Regarding NIBR, only educational foundation hospitals displayed a statistically significant positive effect (8.92 billion KRW per 100 beds; 95% CI, 0.75 to 17.10) compared with the reference group (Table 4).

DISCUSSION

This study examined the financial impact of COVID-19 on hospitals in Korea, focusing on profitability changes across hospital types, geographic locations, and ownership structures. We analyzed 2 key financial indicators: MRPR, which measures operational efficiency and direct profitability from medical services, and NIBR, which captures overall financial health adjusted for hospital size. The findings reveal a bifurcated financial effect: MRPR declined significantly after the onset of COVID-19, whereas NIBR increased overall. This suggests that although direct medical service profitability deteriorated, hospitals maintained or improved net income, likely through government subsidies and operational restructuring. Quadrant analysis showed that national/public hospitals were disproportionately affected, whereas educational foundation hospitals demonstrated relative financial resilience. Mixed-effects regression models further revealed significant differential im-

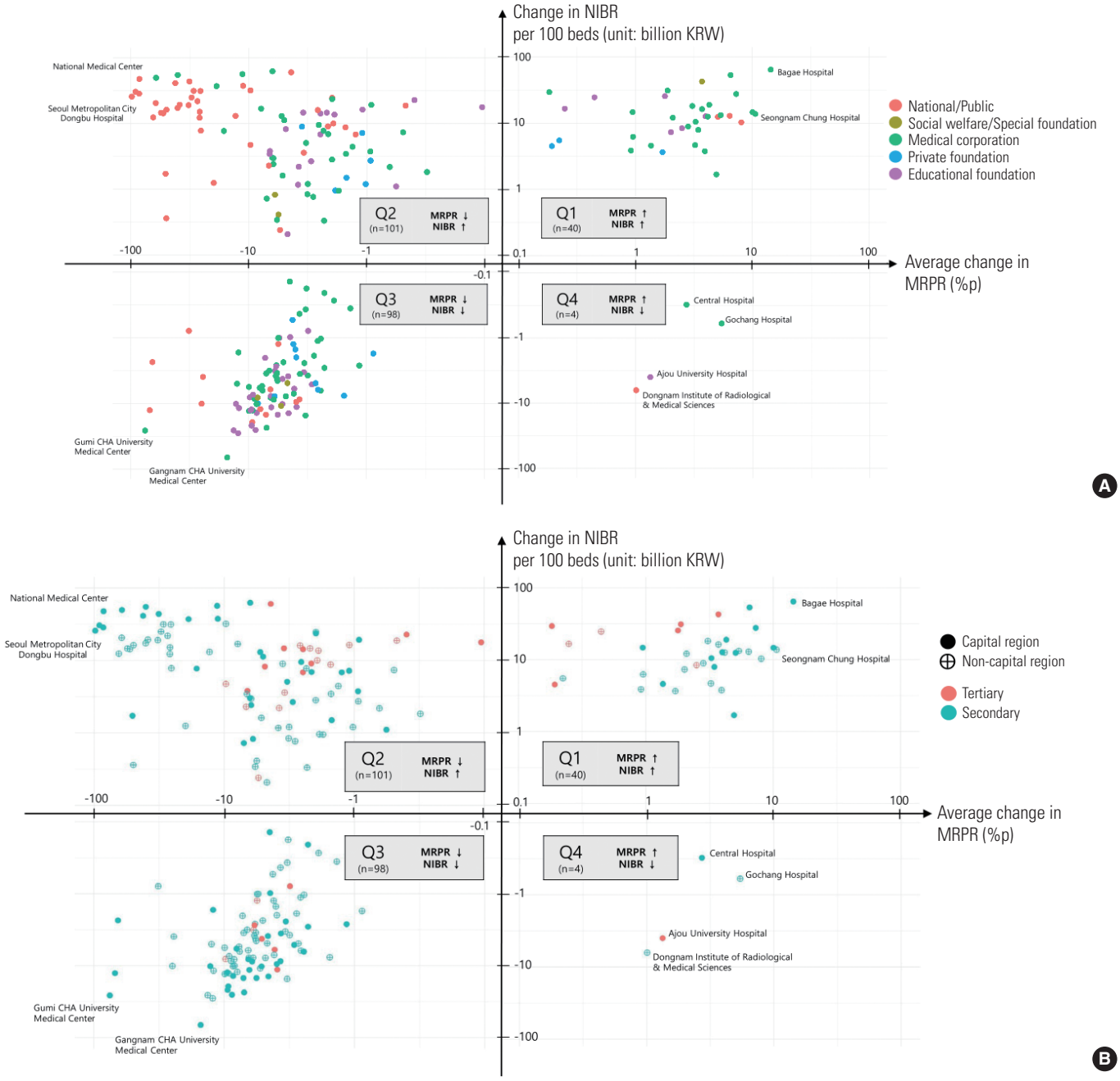

Figure 1. Hospital financial performance matrix: net income before reserve fund allocation (NIBR) versus medical revenue-to-profit ratio (MRPR) changes. (A) shows hospitals color-coded by ownership type. (B) shows hospitals stratified by geographic region and hospital level, with point shape indicating region (capital vs. non-capital) and color indicating hospital level (tertiary vs. secondary). Both axes are presented on a logarithmic scale. Q, quartile; KRW, Korean won.

pacts of the pandemic on hospital finances, highlighting disparities in financial stability and resilience based on hospital characteristics.

These disparities in financial outcomes may reflect underlying structural and managerial differences among hospital types. National/public hospitals, which exhibited significant declines in both MRPR and NIBR, appear to have been more vulnerable to financial strain, possibly due to their disproportionate involvement in frontline COVID-19 care. These institutions likely reallocated resources toward the pandemic response, contributing to the suspension of revenue-generating services such as elective procedures and outpatient visits. Additionally, rela-

Table 4. Impact of coronavirus disease 2019 (COVID-19) on hospital financial performance: regression results

Variable of interest	Medical revenue-to-profit ratio (%)	Net income before reserve fund allocation per 100 beds[1]
Model 1 (effect of time)		
Year	–1.33 (–2.07, –0.59)	–0.89 (–2.75, 0.97)
COVID-19	–1.55 (–2.86, –0.23)	6.67 (3.36, 9.97)
Model 2 (effect of COVID-19)		
Classification		
Tertiary hospital	Reference	Reference
Secondary hospital	–1.90 (–7.27, 3.47)	–1.50 (–11.33, 8.34)
Region		
Capital region	Reference	Reference
Non-capital region	4.16 (1.28, 7.04)	2.32 (–3.10, 7.74)
Ownership		
National/Public	Reference	Reference
Social welfare/ Special foundation	6.77 (–2.37, 15.91)	–5.05 (–22.28, 12.19)
Medical	16.40 (12.80, 20.00)	4.73 (–2.05, 11.51)
Private	11.05 (5.36, 16.74)	2.58 (–8.15, 13.31)
Educational	13.77 (9.41, 18.13)	8.92 (0.75, 17.10)

Values are presented as coefficient (95% confidence interval).
[1]Unit: billion Korean won.

tively rigid budgetary frameworks and limited autonomy in financial management may have complicated rapid adaptation. In contrast, educational foundation hospitals demonstrated greater financial stability, potentially attributable to more diversified funding streams and flexible management structures. Their capacity to implement cost-control strategies and shift toward alternative care delivery models, such as telemedicine, may have helped mitigate financial disruptions.

The financial challenges faced by public hospitals during the COVID-19 period align with prior research. Choi [26] examined a designated infectious disease hospital and found that outpatient and inpatient visits declined by 31.8% and 40.0%, respectively, during the early pandemic, resulting in substantial revenue losses that disproportionately affected vulnerable populations relying on public care. Similarly, Jung and Hwang [27] noted that Korea's comparatively underdeveloped public hospital infrastructure, relative to other Organization for Economic Cooperation and Development (OECD) countries, exacerbated fiscal strain during the COVID-19 pandemic and underscored the need to enhance public hospital capacity through both state funding and strategic private investment. Our study extends these findings by providing a more granular analysis across hospital types, geographic locations, and ownership structures. This detailed approach allowed us to identify significant variations in financial impact not only between public and private hospitals but also among different categories within these broader classifications.

Furthermore, our study makes a significant methodological contribution by introducing a dual-variable analytical framework that captures the multifaceted nature of hospital profitability during crisis periods. Unlike previous studies such as Yang [9], which relied primarily on conventional net-profit metrics and did not fully account for the distinctive features of hospital accounting systems, our approach offers a more nuanced view of financial dynamics. Similarly, Ji and Ok [11] examined individual profitability indicators separately but did not include metrics such as NIBR, which reflects financial status before reserve fund allocations. Our framework integrates both operational efficiency (MRPR) and comprehensive financial health (NIBR), revealing a paradox during the COVID-19 pandemic: direct medical service profitability declined, while overall financial performance improved. This finding underscores the need for policy interventions that not only address immediate financial pressures but also promote long-term operational efficiency and financial resilience across the healthcare system.

This methodological advancement offers valuable insights for policymakers developing targeted financial support strategies for public health emergencies. By recognizing the divergent patterns between operational profitability and overall financial health, government agencies can better differentiate between hospitals requiring immediate operational subsidies and those needing structural financial reforms. Our quadrant-based classification system provides a practical framework for identifying vulnerability patterns across hospital types, enabling more efficient resource allocation during crises. For instance, national/public hospitals displaying negative changes in both MRPR and NIBR (Quadrant 3) may require comprehensive financial restructuring, while those with declining MRPR but improving NIBR (Quadrant 2) might benefit more from interventions aimed at operational efficiency.

This study has notable strengths, including its use of a 7-year longitudinal dataset that supported robust trend analysis across pandemic phases. By employing a dual-variable framework and quadrant analysis, we could provide nuanced insights into hospital financial dynamics beyond conventional single-metric approaches. Importantly, the use of interaction terms be-

tween COVID-19 periods and hospital characteristics within a linear mixed-effects model approximated a DiD structure. This enabled partial attribution of observed financial disparities to pandemic-related impacts rather than time trends alone, enhancing the policy relevance of our findings. Limitations include the use of annual data, which may obscure short-term fluctuations, and potential inconsistencies in NIBR reporting. Additionally, about one-third of hospitals were excluded due to missing data. While many institutions with missing information were psychiatric or nursing hospitals, some were small general hospitals. This exclusion may limit the generalizability of the findings, particularly to smaller or less-resourced institutions.

This study provides one of the first comprehensive quantitative assessments of the financial impact of COVID-19 on Korean hospitals, demonstrating substantial variation in profitability across hospital types, geographic locations, and bed capacities. The findings emphasize the need for targeted financial policies to ensure long-term hospital sustainability, particularly for institutions disproportionately affected by pandemic-related economic shifts. As Korea continues to refine its healthcare financing system, ensuring financial resilience in both public and private hospitals will be critical to maintaining a stable, equitable system capable of responding effectively to future public health crises.

NOTES

Supplemental Materials

Supplemental materials is available at https://doi.org/10.3961/jpmph.25.303.

Conflict of Interest

The authors have no conflicts of interest associated with the material presented in this paper.

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Author Contributions

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