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Title page

A retrospective study of the impact of the COVID-19 pandemic on healthcare utilization: was size of healthcare institution a factor?

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Abstract

Objectives: Many small-sized healthcare institutions play a critical role in communities by preventing infectious diseases. This study examines how they have been impacted by the global COVID-19 pandemic compared to large hospitals.

Design: This study adopted a retrospective study design looking back at the healthcare utilization of medical facilities according to size after the COVID-19 pandemic. The dependent variable was change in the number of outpatient health insurance claims before and after onset of the COVID-19 pandemic. The independent variable was an observation time point of the year 2020 compared to 2019.

Setting and participants: The study was conducted in Korea having a competitive medical provision environment under the national health insurance system. The units of analysis are hospitals and clinics: tertiary hospitals (42), general hospitals (293), small hospitals (1,272), and medical clinics (27,049). This study analysed all the health insurance claim data from January 1, 2019 to December 31, 2020.

Results: Compared with 2019, in 2020, there were significant decreases in the number of claims (-14.9%), particularly in small hospitals (-16.8%) and clinics (-16.3%), with smaller decreases in general hospitals (-8.9%), and tertiary hospitals (-5.3%). The reduction in healthcare utilization increased as the size of institutions decreased. The magnitude of decrease was significantly greatest in small hospitals (RR: 0.8299; 0.7750 to 0.888, $p<0.0001$) followed by clinics (RR: 0.8362; 0.8255 to 0.8470, $p<0.0001$) even after controlling institutional covariates. There was no difference in permanent closures of healthcare institutions between the two years.

Conclusion:

The external impact of the pandemic increased incrementally as the size of healthcare institutions decreased. This finding indicates a need for government support for small healthcare institutions at the time of an epidemic or pandemic. This fact has political implications for how healthcare policy-makers should prepare for the next infectious disease pandemic.

Strengths and limitations of this study

- This study had a methodologically simple study deign comparing the number of health insurance claims in corresponding quarters of two years. The study also had high internal validity due to its large scale, using the entire national data set. The prediction of the study result was based on an organizational theory.
- The study has political implications for what healthcare policy-makers should be aware of and how they can support small hospitals and clinics at the time of the next infectious disease pandemic.
- Limitations include the fact that this study did not consider the healthcare utilization for a longer period before the COVID-19 pandemic, nor did it consider other types of healthcare utilization such as medical costs and inpatient health insurance claims. Interpretation of study results may be limited to Korea, but we plan to extend the analysis to other comparable countries.

INTRODUCTION

The onset of the Covid-19 pandemic at the beginning of 2020 brought worldwide challenges and hugely affected daily life, especially in healthcare utilization[1,2]. United States studies report that healthcare utilization has significantly decreased during the time of the COVID-19 pandemic[3,4]. Hospital admissions for acute coronary syndrome and several other conditions have also significantly declined in the United Kingdom[5,6]. Similar reductions have been observed in several other countries as well[7-11]. The reduction in healthcare utilization could critically affect healthcare institutions by deepening financial losses and halting provision of healthcare services[12-14]. However, there have been few studies on how the COVID-19 pandemic affected small healthcare institutions due to the relatively short period of observational time.

Small healthcare institutions could be especially vulnerable to external impacts because their organizational and financial infrastructure is more fragile than that of large hospitals. One natural phenomenon we can frequently observe is that small things or organisms are more severely affected than larger ones by huge impacts from the same external changes. For example, smaller ships or vessels are more swayed by big waves than larger ships or vessels. Many drug companies conduct clinical trials with small organisms or animals because external effects can be easily observed or detected[15-17]. In the healthcare field, the financial sustainability and profitability of small-scale owner-managed hospitals and small hospitals measured by number of beds is generally speaking most likely to be at risk[18,19].

On the other hand, small healthcare institutions such as small hospitals and clinics play a crucial role in preventing disease and providing healthcare. They act as gatekeepers keeping communities safe, and are at the front line in the fight against disease. If the front line is broken due to lack of supplies or a worsening business eco-system, the impact on the population could be lethal and huge and result in market and governance failure[20] because people could not get any healthcare services[21-25]. Thus it is important to maintain their viability and a sufficient level of supply in the context of environmental change. This means that it is important to ask whether the COVID-19 pandemic has affected all healthcare institutions equally.

Given the short history of the Covid-19 pandemic, it is not surprising that there has not been a previous study of how the pandemic has affected healthcare in relation to the size of healthcare institutions. Only a few studies were reporting the field status of small medical practices experiencing the decline of clinics visits or revenue[26], but they were not adopting academic approaches. This study proposes the hypothesis that the Covid-19 pandemic has affected healthcare differently in terms of the size of healthcare institutions, and specifically, that smaller institutions have experienced significantly greater reductions in utilization than larger institutions.

Resource dependence theory[27,28] may support our prediction. The theory generally explains organizational behavior or decision-making in terms of the organization's resource or power relationship with the external environment. Large hospitals in Korea have an advantage compared to small hospitals because most of their customers have serious conditions and have pre-arranged care schedules funded by the national insurance scheme, so that they have an assured demand. If patients miss appointments in large specialized hospitals, they are not likely to get further appointments because large hospitals generally speaking have very tight schedules. In contrast, small clinics totally depend on choices made by individual patients in the community. In Korea, patients can visit any primary care clinic without having an appointment[29]. A pandemic situation is likely to make patients averse to using healthcare unless their illness is serious. Thus, large healthcare institutions are more likely than smaller ones to have power controlling and stabilizing demand, so that they are less critically affected in terms of healthcare utilization. Hence if COVID-19 affects healthcare utilization, the decrease in healthcare utilization due to the pandemic will depend on the size of healthcare institutions. This study aims to verify this argument through the analysis of quantitative empirical national health insurance data. Theoretical concepts underpinning this study are: a 'power' measured by the 'size' a factor distinguishing types of healthcare institutions, and 'environmental impact' measured by 'changes in numbers of healthcare insurance claims' due to the Covid-19 pandemic.

Therefore, the objective of this study is to investigate the impact of Covid-19 on healthcare utilization across healthcare institutions of different sizes. If Covid-19 has critically affected small healthcare institutions, then our healthcare delivery system could collapse, and this could provide grounds for the government to support small healthcare institutions[30]. This study could provide a basis for plans to prevent such a collapse.

METHODS

Study design

This study adopted a simple retrospective study design comparing an outcome variable for each quarter in 2020 compared with the corresponding quarter in 2019. Many previous studies have adopted a similar design[31-33]. The units of analysis were individual healthcare institutions. There were four types of healthcare institutions in the study: tertiary hospitals (the final number included was 42), general hospitals (293), "hospitals" (referred to here as 'small hospitals' to clearly differentiate them from tertiary and general hospitals: 1,272), and clinics (27,049). These are the standard categories used for the administration of the national health insurance program.

Tertiary hospitals have specific characteristics including a large number of beds and association with a university college of medicine. General hospitals have more than 100 beds. In Korea, small hospitals differ from clinics in that they have 30 or more beds but less than 100 (except mental hospitals). Since the four types of healthcare institution are defined in part by the number of beds, the number of beds was excluded as a variable from the main analysis model, though it was used in a secondary model of closure status.

Several previous studies have used outpatient visits as a healthcare use indicator[34,35]. This study used numbers of health insurance claims for outpatients to measure healthcare utilization, for reasons of simplicity and validity. One outpatient visit creates a claim, thus it is easy to observe and evaluate the extent of healthcare utilization by counting the number of claims. In order to compare institutions under normal operating conditions, this study excluded healthcare institutions which did not have any health insurance claims within a consecutive 3-month period.

Finally, this study received approval from the institutional review board (on March 17, 2021) (IRB number ID: 2021-036-001).

Data sources

This study used health insurance administrative data from the Health Insurance Review and Assessment Service (HIRA). HIRA is a third-party administrator running the national health insurance program in Korea and provides a professional health insurance review and assessment service for the program. As aforementioned, this study targeted all outpatient health insurance claims. The research team extracted all health insurance claims having a date of healthcare from January 1, 2019 to December 31, 2020. Healthcare insurance claims could be submitted long after the actual date that healthcare was provided. This study also included a guideline that review and assessment should be completed by June 30, 2021. According to an unpublished report and general observation by HIRA, 99.99% of health insurance claims are submitted within a 6-month period following the actual provision of healthcare. After extracting the health insurance claims, the claims were aggregated on a quarterly basis for each healthcare organization.

Outcome variables and independent variables

The main dependent variable was the number of outpatient health insurance claims in 2019 and 2020 as used in other studies[36]. This was used as a proxy measure of healthcare utilization. The number of health insurance claims in the two years was compared using four focal time points on a quarterly basis: Q1, Q2, Q3 and Q4. The major independent variables were type of institution, location, and years of operation for each healthcare provider. A market competition measure was included: for hospitals, the Herfindahl-Hirschman Index[37] based on the number of beds; and for clinics, the number of competing

clinics located nearby. Four types of healthcare institutions were studied. The actual number of beds reported to HIRA by healthcare organizations was only used for the secondary model to confirm the annual permanent closure status of healthcare institutions. Ownership (public or private) was only used for general hospitals and small hospitals because most other healthcare institutions are private or for-profit entities. Location was classified as urban if the facilities were located in an area having more than 100,000 residents and as rural if in an area with less than 100,000 residents. Years of operation refers to how many years each facility had been in operation.

Statistical analysis

This study first investigated the descriptive statistics of each healthcare organization in terms of facility size. Group t-tests were used for the numeric values of the main outcome variable: the number of health insurance claims. Before conducting the main analysis, the correlations among the independent variables were investigated, and those having high correlations were excluded from the main analysis in order to avoid multicollinearity in the regression analysis. The number of beds was closely associated with the type of healthcare institutions and so was excluded from the main analysis model. The Modified Park Test was used to determine family of distribution for the generalized linear models[38,39] and the test result suggested a Gamma distribution, which was applied for the model. Thus, the generalized linear models were constructed with link=log and distribution=gamma controlling all institutions' general characteristics. A secondary logistic regression was also conducted in order to see whether there was any significant permanent closure of healthcare institutions. This study used SAS version 9.4 (SAS Institute, Cary, NC, USA) for the data analysis.

Patient and public involvement

Patients and the public were not involved in this study.

RESULTS

General characteristics of the study subjects

Table 1 presents the general characteristics of study subjects. There were 42 tertiary hospitals, mostly in private ownership (71.4%) and located in an urban area (97.6%). There were 293 general hospitals mostly in private ownership (82.6%). Approximately 97 percent of small hospitals were private and most were located in an urban area (90.9%).

Almost all the clinics were private (99.9%) and located in an urban area (93.7%), and 15.2% of clinics had inpatients beds.

Table 1. General characteristics of the study subjects (N = 28,656)

Size of Health Care institution	Variables	Mean or % (SD*)	Min	Max
Tertiary hospitals (N=42)	Years of operation	37.6 (15.6)	12	112
	Ownership: private, %	71.4	-	-
	Location: urban, %**	97.6	-	-
	Number of beds	1,084.2 (433.7)	684.0	2,715.0
	Herfindahl-Hirschman Index	2,006.8(1,146.0)	420.5	5,971.5
General hospital (N=293)	Years of operation	28.0 (12.9)	4.0	61.0
	Ownership: private, %	82.6	-	-
	Location: urban, %	94.2	-	-
	Number of beds	352.7 (181.8)	100.0	1003.0
	Herfindahl-Hirschman Index	1,476.9(1,176.6)	291.0	9,035.2
Small hospitals (N=1,272)	Years of operation	14.6(8.8)	2.0	76.0
	Ownership: private, %	96.6	-	-
	Location: urban, %	90.9	-	-
	Number of beds	110.7(79.9)	30.0	490.0***
	Herfindahl-Hirschman Index	1,416.2(1,246.1)	291.0	10,000.0
Clinics (N=27,049)	Years of operation	17.2(9.4)	2.0	63.0
	Ownership: private, %	99.9	-	-
	Location: urban, %	93.7	-	-
	Having beds, %	15.2	-	-
	Number of clinics nearby	8.9(10.1)	1.0	114.0

*SD: standard deviation; HHI: Herfindahl-Hirschman Index

**: Most institutions are located in urban areas, so this variable was excluded from the main analysis

***: including some mental hospitals having more than 100 beds

Changes in the number of health insurance claims

Table 2 shows the change in the number of health insurance claims in each quarter of 2020 compared with the corresponding quarter of 2019. On average, the number of outpatient health insurance claims decreased by 14.9%. The change was greatest in small hospitals (-16.8%) followed by clinics (-16.3%). The percentage changes for general hospitals and tertiary hospitals were -8.9% and -5.2%, respectively.

Table 2. Changes in health insurance claims between 2019 and 2020 (N = 28,933)

Size of HCI	Period	2019	2020	Change (%)	t-value	p-value
Average number of HIC	Year	25,112	21,372	-14.89	7.67	<0.0001
Tertiary hospitals (N=42)	Q1	254,060	236,972	-6.73	0.47	0.6423
	Q2	261,987	250,264	-4.47	0.30	0.7618
	Q3	270,386	254,865	-5.74	0.39	0.6952
	Q4	269,854	258,675	-4.14	0.28	0.7814
	Total	1,056,286	1,000,777	-5.26	0.36	0.7208
General hospitals (N=293)	Q1	61,466	56,866	-7.48	1.16	0.2479
	Q2	65,215	57,529	-11.79	1.86	0.063
	Q3	65,854	60,898	-7.53	1.18	0.2394
	Q4	65,764	59,993	-8.78	1.38	0.1691
	Total	258,299	235,285	-8.91	1.4	0.1626
Small hospitals (N=1,272)	Q1	11,730	10,332	-11.92	3.77	0.0002
	Q2	12,885	10,255	-20.41	6.71	<0.0001
	Q3	12,648	10,671	-15.63	5.08	<0.0001
	Q4	12,987	10,536	-18.87	6.10	<0.0001
	Total	50,250	41,794	-16.83	5.48	<0.0001
Medical clinics (N=27,049)	Q1	4,669	4,306	-7.77	12.58	<0.0001
	Q2	5,123	4,066	-20.62	35.08	<0.0001
	Q3	4,760	4,142	-12.98	21.21	<0.0001
	Q4	5,252	4,060	-22.69	38.67	<0.0001
	Total	19,803	16,574	-16.31	27.46	<0.0001

H: hospitals, C: clinics, M: medicine; HCI: health care institution, HIC: health insurance claim

Figure 1 presents the overall reduction in healthcare insurance claims and the reduction by type (size) of healthcare institution between the two years, respectively. The analysis clearly shows that the total number of health insurance claims from all healthcare institutions fell, and the magnitude of the reduction increased as the size of healthcare institutions decreased.

Here [Figure 1]. Total number of health insurance claims (2019, 2020)

Changes in health insurance claims after controlling institutional covariates

Table 3 presents the healthcare utilization in 2020 after controlling each healthcare institution's covariates. While the number of health insurance claims from small hospitals (RR: 0.8299; 0.7750 to 0.8888, p<0.0001) and clinics (RR: 0.8362; 0.8255 to 0.8470, p<0.0001) significantly decreased, those of tertiary hospitals and general hospitals did not. The magnitude of the decrease in healthcare utilization was greatest in small hospitals, followed by clinics.

Table 3. Changes in Health Insurance Claims after Controlling Healthcare Institutional Covariates

Size of institution	Variables	Exp (β)	95% CI		p-value
			LL	UL	
Tertiary hospitals (N=42)	Years of operation	0.9975	0.9907	1.0043	0.4674
	Ownership: private(Ref = public)	0.9749	0.7716	1.2318	0.8316
	Herfindahl-Hirschman Index	1.0002	1.0001	1.0003	<.0001
	Observation time point: Year 2020 (Ref =2019)	0.9475	0.7672	1.1702	0.6170
General hospital (N=293)	Years of operation	1.0114	1.0070	1.0158	<.0001
	Ownership: private(Ref = public)	1.1922	1.0302	1.3796	0.0182
	Urban location(Ref = rural)	1.9585	1.4909	2.5731	<.0001
	Herfindahl-Hirschman Index	1.0000	1.0000	1.0001	0.3537
	Observation time point: Year 2020 (Ref =2019)	0.9104	0.8167	1.0148	0.0902
Small Hospitals (N=1,272)	Years of operation	1.0165	1.0122	1.0208	<.0001
	Ownership: public(Ref = private)	2.0228	1.6525	2.4761	<.0001
	Urban location(Ref = rural)	1.2685	1.0863	1.4811	0.0026
	Herfindahl-Hirschman Index	1.0000	1.0000	1.0001	0.1473
	Observation time point: Year 2020 (Ref =2019)	**0.8299**	**0.7750**	**0.8888**	**<.0001**
Clinics (N=27,049)	Years of operation	1.0009	1.0002	1.0016	0.0123
	Urban location(Ref = rural)	0.7837	0.7631	0.8048	<.0001
	Number of clinics nearby	0.9934	0.9928	0.9941	<.0001
	Observation time point: Year 2020 (Ref =2019)	**0.8362**	**0.8255**	**0.8470**	**<.0001**

β: regression coefficients of the generalized linear model for the number of health insurance claims; Exp is the exponential function; CI: confidence interval; LL stands for lower limit and UL stands for upper limit.

Impact of COVID-19 on the Closure of Healthcare Institutions

Table 4 presents factors associated with the permanent closure of healthcare institutions between 2019 and 2020. The analysis shows that there was no significant difference in the number of operating healthcare institutions between the two years. This means that the COVID-19 pandemic did not cause the permanent closure of healthcare institutions.

Table 4. Factors associated with the permanent closure of healthcare institutions with time points before and after the onset of the COVID-19 pandemic

Size of institution*	Variables	Adjusted OR	95% CI		p-value
			LL	UL	
General hospital* (N=2019: 323 2020:329)	Years of operation	0.947	0.906	0.988	0.0130
	Number of beds	0.994	0.989	0.999	0.0256
	Herfindahl-Hirschman Index	1.001	1.000	1.001	<.0001
	Observation time point: 2020 (Ref =2019)	1.041	0.383	2.829	0.9372
Small Hospitals (N=2019: 1,583; 2020:1,603)	Years of operation	0.961	0.941	0.981	0.0001
	Ownership: public(Ref = private)	0.998	0.996	1.000	0.1129
	Number of beds	1.521	0.552	4.192	0.4173
	Herfindahl-Hirschman Index	1.001	1.000	1.001	<.0001
	Observation time point: 2020 (Ref =2019)	0.905	0.655	1.249	0.5421
Clinics (N=2019:33,545; 2020:34,268)	Years of operation	0.986	0.981	0.99	<.0001
	Having beds (Ref=no beds)	1.246	1.114	1.393	0.0001
	Ownership: public(Ref = private)	2.832	0.703	11.409	0.1432
	Number of clinics nearby location	1.004	1.001	1.007	0.0084
	Observation time point: 2020 (Ref =2019)	1.063	0.976	1.157	0.1592

* OR: odds ratio; CI: confidence interval; LL stands for lower limit and UL stands for upper limit; there were no permanent closure events in tertiary hospitals; Excluded variables not having any closure events.

DISCUSSION

This study investigated the impact of COVID-19 on healthcare institutions, especially focusing on small healthcare institutions compared with larger ones. Healthcare utilization was measured by the number of outpatient health insurance claims. Healthcare utilization in the year 2020 was significantly lower by 14.9% compared with 2019. The magnitude of decrease in healthcare utilization was greatest in small hospitals and clinics. However, the decreases for large hospitals (tertiary and general hospitals) were smaller and not significant. In summary, the magnitude of the reduction in healthcare utilization increased as the size of institutions decreased. These findings were not due to any increase or

decrease in permanent closure of hospitals during the time of the COVID-19 pandemic.

These results were aligned with other studies in which most researchers report decreases in healthcare utilization[3,6,8]. In terms of magnitude of decrease, this study found that overall healthcare utilization decreased by 14.9%. According to a study conducted in the United States, overall office visits during the period from March 15 to June 20 decreased by nearly 40% compared to the previous months of 2020[40]. A study conducted in the United Kingdom shows a decrease of 27% comparing outpatient visits from early March to late October 2020 with the same period of the previous year[41]. Although the decline in healthcare utilization may not be directly comparable because each study had different time periods and data sources, the extent of decrease in Korea appears to have been slightly lower than those in other countries. This can be explained as due to governmental actions. To a greater extent than many other countries, the Korean government had implemented organized actions to control the Covid-19 pandemic such as mandatory mask-wearing, coordination of COVID-19 case management, providing COVID-19 diagnostic test kits, introducing telemedicine, and so on[42,43], which might have limited the decrease in healthcare utilization. Large hospitals in Korea also had effective plans for managing COVID-19 and maintaining safe healthcare services to patients[44-45].

In this study, the largest change was observed at small hospitals and clinics compared to large hospitals. This study result is exactly what we expected and one academically verifying some of field experiences and obervations[26]. What can explain this? It is argued here that small facilities are particularly sensitive to the external environment. In the Korean healthcare system, large hospitals may have invisible advantages compared to small hospitals in their institutional rules and practices. In terms of medical demand, patients cannot access tertiary hospitals without referral from primary care clinics or a record of previous hospital visits, making it unlikely that patients visiting large hospitals would stop attending. These institutional rules and practices in the healthcare delivery system would result in little reduction in outpatient visits to tertiary hospitals and general hospitals. Large hospitals have characteristics that mean they are not easy to temporarily close due to the COVID-19 pandemic, because they have many employees and maintenance costs compared to small hospitals and clinics. In contrast, small hospitals and clinics could more easily be closed temporarily because they do not have many employees and they have lower operating costs, and this would lead to lower healthcare utilization.

Limitations

This study has several limitations. First, this study only used a two-year comparison ignoring earlier years. If this study had included previous years' trends, then the results could have had stronger validity. Second, healthcare utilization is strictly speaking different

from the number of health insurance claims. The number of actual visits, medical costs or inpatient hospitalizations would be good examples of healthcare utilization. But this study used the number of health insurance claims as a proxy measure for healthcare utilization. Finally, the interpretation of study results may be limited to Korea because many countries have different healthcare systems. Further research could overcome these limitations.

Study implications

This study has importance from several perspectives. First, this study used all the health insurance claims at the national level covering more than fifty million people. The study results were also based on a hypothesis and organisational theory. Thus, the study has produced a validated figure for the decrease in healthcare utilization due to COVID-19 in Korea as a whole. Second, the study has provided a new finding that the magnitude of changes in healthcare utilization in Korea increases as the size of healthcare institution decreases. There has been little study on this issue in Korea. Third, the study deals with small healthcare institutions such as small hospitals and clinics. Although they play an important role in our communities preventing infectious diseases, there has been a lack of research focusing on how they are affected by the COVID-19 pandemic. Government could take appropriate political action by using our results to support these institutions in times of pandemics such as COVID-19. The results could contribute to developing a sustainable healthcare delivery system through governmental support. Finally, this study identified that there was relatively less reduction of healthcare utilization in Korea compared to other nations. Considering the high population density in Korea, the relatively small reduction in healthcare utilization stands as an achievement of the Korean government in the management of healthcare systems. A national level figure for the reduction in healthcare utilization provides a representative benchmark for comparison with other countries.

CONCLUSION

This study has verified that there was a significant decrease in healthcare utilization in Korea during the time of COVID-19 pandemic compared to the previous year, which is aligned with other studies on healthcare utilization. However, the magnitude of change increases as the size of healthcare institutions decreases. The greatest decrease occurred at small hospitals followed by medical clinics. This study raises a political question of how to support these small healthcare institutions at the time of an infectious disease pandemic and whether healthcare in small healthcare institutions is really non-essential. But given that small clinics and hospitals are important and it is clear that they are affected by environmental factors, it follows that healthcare policy makers need to pay more attention

to whether there could be gaps in the provision of everyday healthcare.

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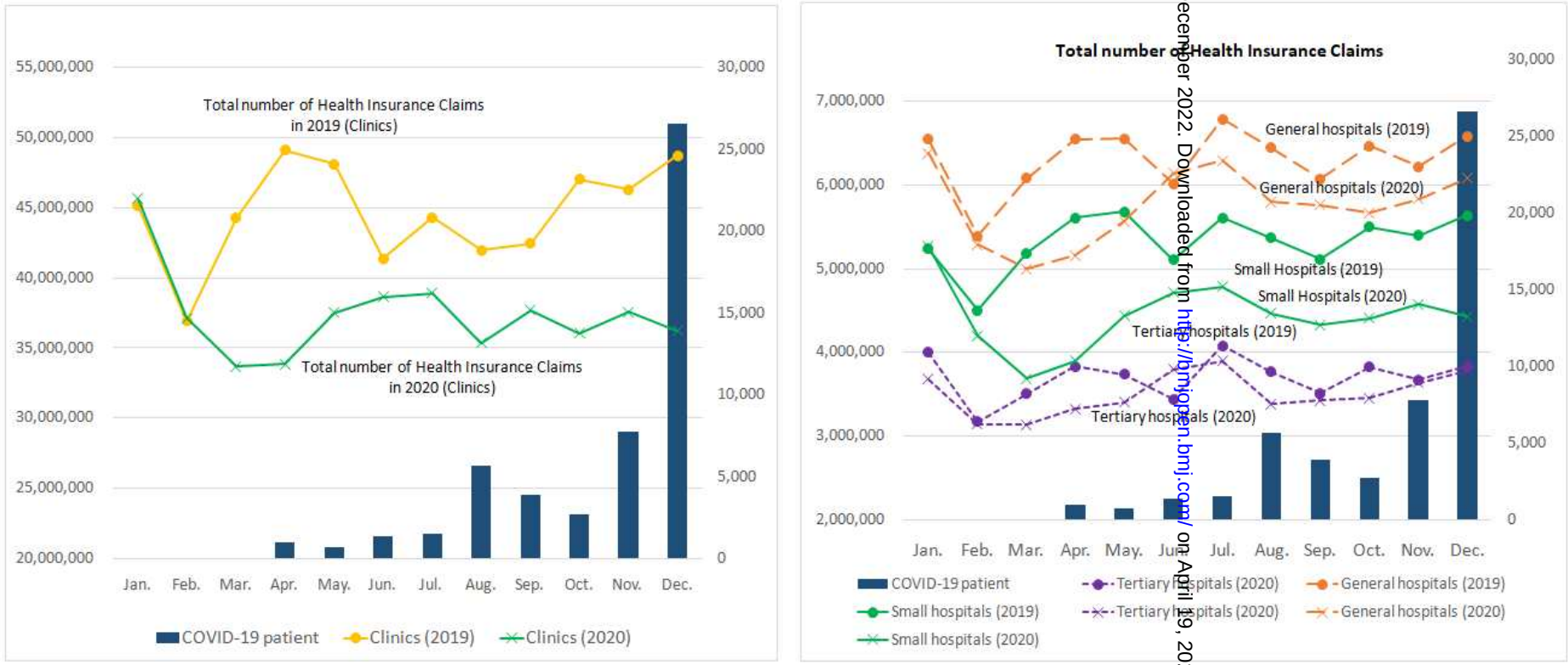

Figure 1. Total number of health insurance claims (2019, 2020)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6 7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	-
		Results	
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	8,9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10,11

		(*b*) Report category boundaries when continuous variables were categorized	8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11,12
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12,13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11,12, 13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Was size of healthcare institution a factor affecting changes in healthcare utilization during the Covid-19 pandemic in Korea? A retrospective study design analyzing national healthcare big data

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Title page

Was size of healthcare institution a factor affecting changes in healthcare utilization during the Covid-19 pandemic in Korea? A retrospective study design analyzing national healthcare big data

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Abstract

Objectives: Many small-sized healthcare institutions play a critical role in communities by preventing infectious diseases. This study examines how they have been impacted by the global Covid-19 pandemic compared to large hospitals.

Design: This study adopted a retrospective study design looking back at the healthcare utilization of medical facilities according to size after the Covid-19 pandemic. The dependent variable was change in the number of outpatient health insurance claims before and after onset of the Covid-19 pandemic. The independent variable was an observation time point of the year 2020 compared to 2019.

Setting and participants: The study was conducted in Korea having a competitive medical provision environment under the national health insurance system. The units of analysis are hospitals and clinics: tertiary hospitals (42), general hospitals (293), small hospitals (1,272), and medical clinics (27,049). This study analysed all the health insurance claim data from January 1, 2019 to December 31, 2020.

Results: Compared with 2019, in 2020, there were significant decreases in the number of claims (-14.9%), particularly in small hospitals (-16.8%) and clinics (-16.3%), with smaller decreases in general hospitals (-8.9%), and tertiary hospitals (-5.3%). The reduction in healthcare utilization increased as the size of institutions decreased. The magnitude of decrease was significantly greatest in small hospitals (Absolute risk (AR):0.8317, 0.7758 to 0.8915, $p<0.0001$; Relative risk (RR): 0.8299, 0.7750 to 0.888, $p<0.0001$) followed by clinics (AR: 0.8369, 0.8262 to 0.8478, $p<0.0001$; RR: 0.8362, 0.8255 to 0.8470, $p<0.0001$) even after controlling institutional covariates.

Conclusion:

The external impact of the pandemic increased incrementally as the size of healthcare institutions decreased. Healthcare policy-makers need to keep in mind the possibility that small hospitals and clinics may experience reduced healthcare utilization in the infectious disease pandemic. This fact has political implications for how healthcare policy-makers should prepare for the next infectious disease pandemic.

Strengths and limitations of this study

- This study had a methodologically simple study design comparing the number of outpatient health insurance claims in corresponding quarters of two years before and after the onset of the pandemic of Covid-19.
- This study used the entire national data set to represent the national healthcare utilization in the years 2019 and 2020.
- As for limitations, this study did not consider the healthcare utilization for a longer period before the Covid-19 pandemic, which may result in not reflecting the effect of any longitudinal trend on the study results.
- This study also did not consider other types of healthcare utilization such as medical costs and inpatient health insurance claims.

INTRODUCTION

The onset of the Covid-19 pandemic at the beginning of 2020 brought worldwide challenges and hugely affected daily life, especially in healthcare utilization [1,2]. United States studies report that healthcare utilization has significantly decreased during the time of the Covid-19 pandemic[3,4]. Hospital admissions for acute coronary syndrome and several other conditions have also significantly declined in the United Kingdom[5,6]. Similar reductions have been observed in several other countries as well[7-11]. The reduction in healthcare utilization could critically affect healthcare institutions by deepening financial losses and halting provision of healthcare services[12-14]. However, there have been few studies on how the Covid-19 pandemic affected small healthcare institutions due to the relatively short period of observational time.

Small healthcare institutions could be especially vulnerable to external impacts because their organizational and financial infrastructure is more fragile than that of large hospitals. One natural phenomenon we can frequently observe is that small things or organisms are more severely affected than larger ones by huge impacts from the same external changes. For example, smaller ships or vessels are more swayed by big waves than larger ships or vessels. Many drug companies conduct clinical trials with small organisms or animals because external effects can be easily observed or detected[15-17]. In the healthcare field, the financial sustainability and profitability of small-scale owner-managed hospitals and small hospitals measured by number of beds is generally speaking most likely to be at risk[18,19].

On the other hand, small healthcare institutions such as small hospitals and clinics play a crucial role in preventing disease and providing healthcare. They act as gatekeepers keeping communities safe, and are at the front line in the fight against disease. If the front line is broken due to lack of supplies or a worsening business eco-system, the impact on the population could be lethal and huge and result in market and governance failure[20] because people could not get any healthcare services[21-25]. Thus it is important to maintain their viability and a sufficient level of supply in the context of environmental change. This means that it is important to ask whether the Covid-19 pandemic has affected all healthcare institutions equally.

Given the short history of the Covid-19 pandemic, it is not surprising that there has not been a previous study of how the pandemic has affected healthcare in relation to the size of healthcare institutions. Only a few studies were reporting the field status of small medical practices experiencing the decline of clinics visits or revenue[26], but they were not adopting academic approaches. This study proposes the hypothesis that the Covid-19 pandemic has affected healthcare differently in terms of the size of healthcare institutions, and specifically, that smaller institutions have experienced significantly greater reductions in

utilization than larger institutions.

Resource dependence theory[27,28] may support our prediction. The theory generally explains organizational behavior or decision-making in terms of the organization's resource or power relationship with the external environment. Large hospitals in Korea have an advantage compared to small hospitals because most of their customers have serious conditions and have pre-arranged care schedules funded by the national insurance scheme, so that they have an assured demand. In Korea, patients can visit any primary care clinic without having any booking status[29]. A pandemic situation is likely to make patients averse to using healthcare unless their illness is serious. Thus, large healthcare institutions are more likely than smaller ones to have power controlling and stabilizing demand, so that they are less critically affected in terms of healthcare utilization. Hence if Covid-19 affects healthcare utilization, the decrease in healthcare utilization due to the pandemic will depend on the size of healthcare institutions. This study aims to verify this argument through the analysis of quantitative empirical national health insurance data. Theoretical concepts underpinning this study are: a 'power' measured by the 'size' a factor distinguishing types of healthcare institutions, and 'environmental impact' measured by 'changes in numbers of healthcare insurance claims' due to the Covid-19 pandemic.

Therefore, the objective of this study is to investigate the impact of Covid-19 on healthcare utilization across healthcare institutions of different sizes. If Covid-19 has critically affected small healthcare institutions, then our healthcare delivery system could collapse, and this could provide grounds for the government to support small healthcare institutions[30]. This study could provide a basis for plans to prevent such a collapse.

METHODS

Study design

This study adopted a simple retrospective study design comparing an outcome variable for each quarter in 2020 compared with the corresponding quarter in 2019. Many previous studies have adopted a similar design[31-33]. The units of analysis were individual healthcare institutions. There were four types of healthcare institutions in the study: tertiary hospitals (the final number included was 42), general hospitals (293), "hospitals" (referred to here as 'small hospitals' to clearly differentiate them from tertiary and general hospitals: 1,272), and clinics (27,049). These are the standard categories used for the administration of the national health insurance program.

Tertiary hospitals have specific characteristics including a large number of beds and association with a university college of medicine. General hospitals have more than 100

beds. In Korea, small hospitals differ from clinics in that they have 30 or more beds but less than 100 (except mental hospitals). Small hospitals and clinics perform a primary care gateway role. Clinics have less than 30 beds, and some have none at all. If clinics do not have any beds and provide healthcare to outpatients, then the reimbursement processing is filed as outpatient health insurance claims. If they provided healthcare using beds such as hospitalization, then the claim would be filed as inpatient health insurance claim. Thus, whether clinics have or do not have beds does not affect the outcome measure of this study because this study only considered outpatient health insurance claims. Since the four types of healthcare institution are defined in part by the number of beds, the number of beds was excluded as a variable from the main analysis model, though it was used in a secondary model of closure status.

Several previous studies have used outpatient visits as a healthcare use indicator[34,35]. This study used numbers of health insurance claims for outpatients to measure healthcare utilization, for reasons of simplicity and validity. One outpatient visit creates a claim, thus it is easy to observe and evaluate the extent of healthcare utilization by counting the number of claims. We only counted the actual number of outpatient visits during each year (2019, 2020). In order to compare institutions under normal operating conditions, this study excluded healthcare institutions which did not have any health insurance claims within a consecutive 3-month period.

Finally, this study received approval from the institutional review board (on March 17, 2021) (IRB number ID: 2021-036-001).

Data sources

This study used health insurance administrative data from the Health Insurance Review and Assessment Service (HIRA). HIRA is a third-party administrator running the national health insurance program in Korea and provides a professional health insurance review and assessment service for the program. As aforementioned, this study targeted all outpatient health insurance claims. The research team extracted all health insurance claims having a date of healthcare from January 1, 2019 to December 31, 2020. Healthcare insurance claims could be submitted long after the actual date that healthcare was provided. This study also included a guideline that review and assessment should be completed by June 30, 2021. According to an unpublished report and general observation by HIRA, 99.99% of health insurance claims are submitted within a 6-month period following the actual provision of healthcare. After extracting the health insurance claims, the claims were aggregated on a quarterly basis for each healthcare organization.

Outcome variables and independent variables

The main dependent variable was the number of outpatient health insurance claims in 2019

and 2020 as used in other studies[36]. This was used as a proxy measure of healthcare utilization. The number of health insurance claims in the two years was compared using four focal time points on a quarter(Q) basis: Q1, Q2, Q3 and Q4. The major independent variables were type of institution, location, and years of operation for each healthcare provider. A market competition measure was included: for hospitals, the Herfindahl-Hirschman Index[37] based on the number of beds; and for clinics, the number of competing clinics located nearby. Four types of healthcare institutions were studied. The actual number of beds reported to HIRA by healthcare organizations was only used for the secondary model to confirm the annual permanent closure status of healthcare institutions. Ownership (public or private) was only used for general hospitals and small hospitals because most other healthcare institutions are private or for-profit entities. Location was classified as urban if the facilities were located in an area having more than 100,000 residents and as rural if in an area with less than 100,000 residents. Years of operation refers to how many years each facility had been in operation.

Statistical analysis

This study first investigated the descriptive statistics of each healthcare organization in terms of facility size. Group t-tests were used for the numeric values of the main outcome variable: the number of health insurance claims. Before conducting the main analysis, the correlations among the independent variables were investigated, and those having high correlations were excluded from the main analysis in order to avoid multicollinearity in the regression analysis. The number of beds was closely associated with the type of healthcare institutions and so was excluded from the main analysis model. The Modified Park Test was used to determine family of distribution for the generalized linear models[38,39] and the test result suggested a Gamma distribution, which was applied for the model. Thus, the generalized linear models were constructed with link=log and distribution=gamma controlling all institutions' general characteristics. A secondary logistic regression was also conducted in order to see whether there was any significant permanent closure of healthcare institutions. This study used SAS version 9.4 (SAS Institute, Cary, NC, USA) for the data analysis.

Patient and public involvement

Patients and the public were not involved in this study.

RESULTS

General characteristics of the study subjects

Table 1 presents the general characteristics of study subjects. There were 42 tertiary hospitals, mostly in private ownership (71.4%) and located in an urban area (97.6%). There were 293 general hospitals mostly in private ownership (82.6%). Approximately 97 percent of small hospitals were private and most were located in an urban area (90.9%). Almost all the clinics were private (99.9%) and located in an urban area (93.7%), and 15.2% of clinics had inpatients beds.

Table 1. General characteristics of the study subjects (N = 28,656)

Size of Health Care institution	Variables	Mean or % (SD*)	Min	Max
Tertiary hospitals (N=42)	Years of operation	37.6 (15.6)	12	112
	Ownership: private, %	71.4	-	-
	Location: urban, %**	97.6	-	-
	Number of beds	1,084.2 (433.7)	684.0	2,715.0
	Herfindahl-Hirschman Index	2,006.8(1,146.0)	420.5	5,971.5
General hospital (N=293)	Years of operation	28.0 (12.9)	4.0	61.0
	Ownership: private, %	82.6	-	-
	Location: urban, %	94.2	-	-
	Number of beds	352.7 (181.8)	100.0	1003.0
	Herfindahl-Hirschman Index	1,476.9(1,176.6)	291.0	9,035.2
Small hospitals (N=1,272)	Years of operation	14.6(8.8)	2.0	76.0
	Ownership: private, %	96.6	-	-
	Location: urban, %	90.9	-	-
	Number of beds	110.7(79.9)	30.0	490.0***
	Herfindahl-Hirschman Index	1,416.2(1,246.1)	291.0	10,000.0
Clinics (N=27,049)	Years of operation	17.2(9.4)	2.0	63.0
	Ownership: private, %	99.9	-	-
	Location: urban, %	93.7	-	-
	Having beds, %	15.2	-	-
	Number of clinics nearby	8.9(10.1)	1.0	114.0

*SD: standard deviation; HHI: Herfindahl-Hirschman Index

**: Most institutions are located in urban areas, so this variable was excluded from the main analysis

***: including some mental hospitals having more than 100 beds

Changes in the number of health insurance claims

Table 2 shows the change in the number of health insurance claims in each quarter of 2020

compared with the corresponding quarter of 2019. On average, the number of outpatient health insurance claims decreased by 14.9%. The change was greatest in small hospitals (-16.8%) followed by clinics (-16.3%). The percentage changes for general hospitals and tertiary hospitals were -8.9% and -5.2%, respectively.

Table 2. Changes in health insurance claims between 2019 and 2020 (N = 28,933)

Size of HCI	Period	2019	2020	Change (%)	t-value	p-value
Average number of HIC	Year	25,112	21,372	-14.89	7.67	<0.0001
Tertiary hospitals (N=42)	Q1	254,060	236,972	-6.73	0.47	0.6423
	Q2	261,987	250,264	-4.47	0.30	0.7618
	Q3	270,386	254,865	-5.74	0.39	0.6952
	Q4	269,854	258,675	-4.14	0.28	0.7814
	Total	1,056,286	1,000,777	-5.26	0.36	0.7208
General hospitals (N=293)	Q1	61,466	56,866	-7.48	1.16	0.2479
	Q2	65,215	57,529	-11.79	1.86	0.063
	Q3	65,854	60,898	-7.53	1.18	0.2394
	Q4	65,764	59,993	-8.78	1.38	0.1691
	Total	258,299	235,285	-8.91	1.4	0.1626
Small hospitals (N=1,272)	Q1	11,730	10,332	-11.92	3.77	0.0002
	Q2	12,885	10,255	-20.41	6.71	<0.0001
	Q3	12,648	10,671	-15.63	5.08	<0.0001
	Q4	12,987	10,536	-18.87	6.10	<0.0001
	Total	50,250	41,794	-16.83	5.48	<0.0001
Medical clinics (N=27,049)	Q1	4,669	4,306	-7.77	12.58	<0.0001
	Q2	5,123	4,066	-20.62	35.08	<0.0001
	Q3	4,760	4,142	-12.98	21.21	<0.0001
	Q4	5,252	4,060	-22.69	38.67	<0.0001
	Total	19,803	16,574	-16.31	27.46	<0.0001

H: hospitals, C: clinics, M: medicine; HCI: health care institution, HIC: health insurance claim

Figure 1 presents the overall reduction in healthcare insurance claims and the reduction by type (size) of healthcare institution between the two years, respectively. The analysis clearly shows that the total number of health insurance claims from all healthcare institutions fell, and the magnitude of the reduction increased as the size of healthcare institutions decreased.

Here [Figure 1]. Total number of health insurance claims (2019, 2020)

Changes in health insurance claims after controlling institutional covariates

Table 3 presents the healthcare utilization in 2020 before and after controlling each healthcare institution's covariates. While the number of health insurance claims from small hospitals (Absolute risk (AR): 0.8317, 0.7758 to 0.8915, p<0.0001; Relative risk(RR): 0.8299, 0.7750 to 0.8888, p<0.0001) and clinics (AR: 0.8369, 0.8262 to 0.8478, p<0.0001; RR: 0.8362, 0.8255 to 0.8470, p<0.0001) significantly decreased, those of tertiary hospitals and general hospitals did not. The magnitude of the decrease in healthcare utilization was greatest in small hospitals, followed by clinics.

Table 3. Changes in Health Insurance Claims after Controlling Healthcare Institutional Covariates

Size of institution	Variables	Not controlling hospital covariates (Absolute risk)				Controlling hospital covariates (Relative risk)			
		Exp (β)	95% CI		p-value	Exp (β)	95% CI		p-value
			LL	UL			LL	UL	
Tertiary hospitals (N=42)	Years of operation					0.9975	0.9907	1.0043	0.4674
	Ownership: private (Ref = public)					0.9749	0.7716	1.2318	0.8316
	Herfindahl-Hirschman Index					1.0002	1.0001	1.0003	<.0001
	Observation time point: Year 2020 (Ref =2019)	0.9474	0.7518	1.1940	0.6474	0.9475	0.7672	1.1702	0.6170
General hospital (N=293)	Years of operation					1.0114	1.0070	1.0158	<.0001
	Ownership: private (Ref = public)					1.1922	1.0302	1.3796	0.0182
	Urban location (Ref = rural)					1.9585	1.4909	2.5731	<.0001
	Herfindahl-Hirschman Index					1.0000	1.0000	1.0001	0.3537
	Observation time point: Year 2020 (Ref =2019)	0.9109	0.8133	1.0202	0.1065	0.9104	0.8167	1.0148	0.0902
Small Hospitals (N=1,272)	Years of operation					1.0165	1.0122	1.0208	<.0001
	Ownership: public (Ref = private)					2.0228	1.6525	2.4761	<.0001
	Urban location (Ref = rural)					1.2685	1.0863	1.4811	0.0026
	Herfindahl-Hirschman Index					1.0000	1.0000	1.0001	0.1473
	Observation time point: Year 2020 (Ref =2019)	0.8317	0.7758	0.8915	<.0001	0.8299	0.7750	0.8888	<.0001
Clinics (N=27,049)	Years of operation					1.0009	1.0002	1.0016	0.0123
	Urban location (Ref = rural)					0.7837	0.7631	0.8048	<.0001
	Number of clinics nearby					0.9934	0.9928	0.9941	<.0001
	Observation time point: Year 2020 (Ref =2019)	0.8369	0.8262	0.8478	<.0001	0.8362	0.8255	0.8470	<.0001

β: regression coefficients of the generalized linear model for the number of health insurance claims; Exp is the exponential function; CI: confidence interval; LL stands for lower limit and UL stands for upper limit.

Impact of Covid-19 on the Closure of Healthcare Institutions

Table 4 presents factors associated with the permanent closure of healthcare institutions between 2019 and 2020. The analysis shows that there was no significant difference in the number of operating healthcare institutions between the two years. This means that the Covid-19 pandemic did not cause the permanent closure of healthcare institutions.

Table 4. Factors associated with the permanent closure of healthcare institutions with time points before and after the onset of the Covid-19 pandemic

Size of institution*	Variables	Adjusted OR	95% CI		p-value
			LL	UL	
General hospital* (N=2019: 323 2020:329)	Years of operation	0.947	0.906	0.988	0.0130
	Number of beds	0.994	0.989	0.999	0.0256
	Herfindahl-Hirschman Index	1.001	1.000	1.001	<.0001
	Observation time point: 2020 (Ref =2019)	1.041	0.383	2.829	0.9372
Small Hospitals (N=2019: 1,583; 2020:1,603)	Years of operation	0.961	0.941	0.981	0.0001
	Ownership: public(Ref = private)	0.998	0.996	1.000	0.1129
	Number of beds	1.521	0.552	4.192	0.4173
	Herfindahl-Hirschman Index	1.001	1.000	1.001	<.0001
	Observation time point: 2020 (Ref =2019)	0.905	0.655	1.249	0.5421
Clinics (N=2019:33,545; 2020:34,268)	Years of operation	0.986	0.981	0.99	<.0001
	Having beds (Ref=no beds)	1.246	1.114	1.393	0.0001
	Ownership: public(Ref = private)	2.832	0.703	11.409	0.1432
	Number of clinics nearby location	1.004	1.001	1.007	0.0084
	Observation time point: 2020 (Ref =2019)	1.063	0.976	1.157	0.1592

* OR: odds ratio; CI: confidence interval; LL stands for lower limit and UL stands for upper limit; there were no permanent closure events in tertiary hospitals; Excluded variables not having any closure events.

DISCUSSION

This study investigated the impact of Covid-19 on healthcare institutions, especially focusing on small healthcare institutions compared with larger ones. Healthcare utilization was measured by the number of outpatient health insurance claims. Healthcare utilization in the year 2020 was significantly lower by 14.9% compared with 2019. The magnitude of decrease in healthcare utilization was greatest in small hospitals and clinics. However, the decreases for large hospitals (tertiary and general hospitals) were smaller and not significant. In summary, the magnitude of the reduction in healthcare utilization increased as the size of institutions decreased. These findings were not due to any increase or

decrease in permanent closure of hospitals during the time of the Covid-19 pandemic.

These results were aligned with other studies in which most researchers report decreases in healthcare utilization[3,6,8]. In terms of magnitude of decrease, this study found that overall healthcare utilization decreased by 14.9%. According to a study conducted in the United States, overall office visits during the period from March 15 to June 20 decreased by nearly 40% compared to the previous months of 2020[40]. A study conducted in the United Kingdom shows a decrease of 27% comparing outpatient visits from early March to late October 2020 with the same period of the previous year[41]. Although the decline in healthcare utilization may not be directly comparable because each study had different time periods and data sources, the extent of decrease in Korea appears to have been slightly lower than those in other countries. This can be explained as due to governmental actions. To a greater extent than many other countries, the Korean government had implemented organized actions to control the Covid-19 pandemic such as mandatory mask-wearing, coordination of Covid-19 case management, providing Covid-19 diagnostic test kits, introducing telemedicine, and so on[42,43], which might have limited the decrease in healthcare utilization. Large hospitals in Korea also had effective plans for managing Covid-19 and maintaining safe healthcare services to patients[44,45].

In this study, the largest change was observed at small hospitals and clinics compared to large hospitals. This study result is exactly what we expected and one academically verifying some of field experiences and observations[26]. What can explain this? It is argued here that small facilities are particularly sensitive to the external environment. In the Korean healthcare system, large hospitals may have invisible advantages compared to small hospitals in their institutional rules and practices. In terms of medical demand, patients cannot access tertiary hospitals without referral from primary care clinics or a record of previous hospital visits, making it unlikely that patients visiting large hospitals would stop attending. These institutional rules and practices in the healthcare delivery system would result in little reduction in outpatient visits to tertiary hospitals and general hospitals. Large hospitals have characteristics that mean they are not easy to temporarily close due to the COVID-19 pandemic, because they have many employees and maintenance costs compared to small hospitals and clinics. In contrast, small hospitals and clinics could more easily be closed temporarily because they do not have many employees and they have lower operating costs, and this would lead to lower healthcare utilization.

Limitations

This study has several limitations. First, this study only used a two-year comparison ignoring earlier years. This fact may result in some internal validity issues caused by ignoring previous long-term trends or some confounding factors. Although this study used

all the outpatient health insurance claims, the large sample size does not guarantee high internal validity, but increases the statistical power. If this study had included previous years' trends, then the study could have had more accurate results. Second, healthcare utilization is strictly speaking different from the number of health insurance claims. The number of actual visits, medical costs or inpatient hospitalizations would be good examples of healthcare utilization. But this study used the number of health insurance claims as a proxy measure for healthcare utilization. Finally, the interpretation of study results may be limited to Korea because many countries have different healthcare systems. Further research could overcome these limitations.

Study implications

This study has importance from several perspectives. First, this study used all the health insurance claims at the national level covering more than fifty million people. The study results were also based on a hypothesis and organisational theory. Thus, the study has produced a validated figure for the decrease in healthcare utilization due to Covid-19 in Korea as a whole. Second, the study has provided a new finding that the magnitude of changes in healthcare utilization in Korea increases as the size of healthcare institution decreases. There has been little study on this issue in Korea. Third, the study deals with small healthcare institutions such as small hospitals and clinics. Although they play an important role in our communities preventing infectious diseases, there has been a lack of research focusing on how they are affected by the Covid-19 pandemic. Government could take appropriate political action by using our results to support these institutions in times of pandemics such as Covid-19. The results could contribute to developing a sustainable healthcare delivery system through governmental support. Fourth, this study identified that there was relatively less reduction of healthcare utilization in Korea compared to other nations. Considering the high population density in Korea, the relatively small reduction in healthcare utilization stands as an achievement of the Korean government in the management of healthcare systems. A national level figure for the reduction in healthcare utilization provides a representative benchmark for comparison with other countries. Finally, this study raises a question as to whether the study findings are generalizable to other nations and provides an opportunity to test the study findings. We argue that each nation has its own categories of healthcare facilities and, thus, there would be a very low possibility of having the exactly same research settings. However, there are some similarities between Korea and other Asian countries, especially Taiwan and Japan. For example, medical facilities called "clinics" in Korea, Taiwan, and Japan are ones run by 1 to 5 physicians and some of them may have beds in all three countries. There are also tertiary hospitals in Taiwan although the size and specific definition of the tertiary hospitals is

different from that in Korea[46,47]. The definition of "clinics" and "hospital" in Japan is almost the same as that in Korea[48]. Although the gatekeeper role of clinics is weak in Korea, the gatekeeper role is similar to that of primary care clinics in the U.K. Thus, this study provides an opportunity to other nations or international colleagues to test whether environmental impacts such as the Covid-19 pandemic affect healthcare institutions differently depending on the size of those institutions.

CONCLUSION

This study has verified that there was a significant decrease in healthcare utilization in Korea during the time of Covid-19 pandemic compared to the previous year, which is aligned with other studies on healthcare utilization. However, the magnitude of change increases as the size of healthcare institutions decreases. The greatest decrease occurred at small hospitals followed by medical clinics. This study raises a political question of how to support these small healthcare institutions at the time of an infectious disease pandemic and whether healthcare in small healthcare institutions is really non-essential. But given that small clinics and hospitals are important and it is clear that they are affected by environmental factors, it follows that healthcare policy makers need to pay more attention to whether there could be gaps in the provision of everyday healthcare.

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Ethics approval: The study was approved by the Institutional Review Board of Health Insurance Review and Assessment Service (HIRA) in Korea (IRB number: 2021-036-001).

Provenance and peer review: Not commissioned; externally peer reviewed

Data availability statement: Data may be obtained from a third party and are not publicly available. The data are healthcare institution's organizational characteristics and the number of monthly outpatient health insurance claims in each healthcare institution from January 1, 2019 to December 31, 2020. Because of the sensitive nature of the data collected for this study, requests to access the dataset may be sent to the Health Insurance Review and Assessment Service (HIRA) in Korea and the data may be obtained from the HIRA upon reasonable request.

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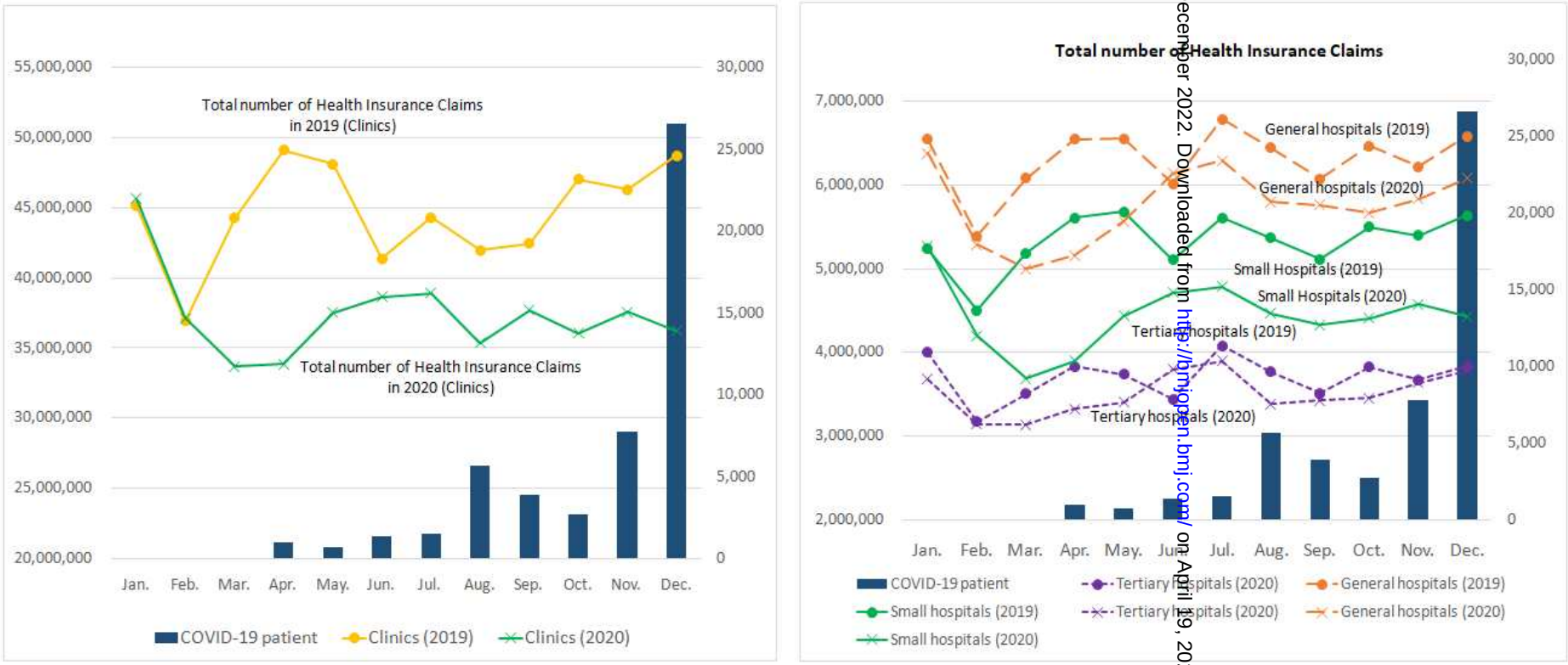

Figure 1. Total number of health insurance claims (2019, 2020)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4, 5
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6 7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6, 7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	-
		Results	
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	8,9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10,11

		(*b*) Report category boundaries when continuous variables were categorized	8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11,12
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12,13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11,12, 13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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Was size of healthcare institution a factor affecting changes in healthcare utilization during the Covid-19 pandemic in Korea? A retrospective study design analyzing national healthcare big data

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Title page

Was size of healthcare institution a factor affecting changes in healthcare utilization during the Covid-19 pandemic in Korea? A retrospective study design analyzing national healthcare big data

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Abstract

Objectives: Many small-sized healthcare institutions play a critical role in communities by preventing infectious diseases. This study examines how they have been impacted by the global Covid-19 pandemic compared to large hospitals.

Design: This study adopted a retrospective study design looking back at the healthcare utilization of medical facilities according to size after the Covid-19 pandemic. The dependent variable was change in the number of outpatient health insurance claims before and after onset of the Covid-19 pandemic. The independent variable was an observation time point of the year 2020 compared to 2019.

Setting and participants: The study was conducted in Korea having a competitive medical provision environment under the national health insurance system. The units of analysis are hospitals and clinics: tertiary hospitals (42), general hospitals (293), small hospitals (1,272), and medical clinics (27,049). This study analysed all the health insurance claim data from January 1, 2019 to December 31, 2020.

Results: Compared with 2019, in 2020, there were significant decreases in the number of claims (-14.9%), particularly in small hospitals (-16.8%) and clinics (-16.3%), with smaller decreases in general hospitals (-8.9%), and tertiary hospitals (-5.3%). The reduction in healthcare utilization increased as the size of institutions decreased. The magnitude of decrease was significantly greatest in small hospitals (Absolute risk (AR):0.8317, 0.7758 to 0.8915, $p<0.0001$; Relative risk (RR): 0.8299, 0.7750 to 0.888, $p<0.0001$) followed by clinics (AR: 0.8369, 0.8262 to 0.8478, $p<0.0001$; RR: 0.8362, 0.8255 to 0.8470, $p<0.0001$) even after controlling institutional covariates.

Conclusion:

The external impact of the pandemic increased incrementally as the size of healthcare institutions decreased. Healthcare policy-makers need to keep in mind the possibility that small hospitals and clinics may experience reduced healthcare utilization in the infectious disease pandemic. This fact has political implications for how healthcare policy-makers should prepare for the next infectious disease pandemic.

Strengths and limitations of this study

- This study had a methodologically simple study design comparing the number of outpatient health insurance claims in corresponding quarters of two years before and after the onset of the pandemic of Covid-19.
- This study used the entire national data set to represent the national healthcare utilization in the years 2019 and 2020.
- As for limitations, this study did not consider the healthcare utilization for a longer period before the Covid-19 pandemic, which may result in not reflecting the effect of any longitudinal trend on the study results.
- This study also did not consider other types of healthcare utilization such as medical costs and inpatient health insurance claims.

INTRODUCTION

The onset of the Covid-19 pandemic at the beginning of 2020 brought worldwide challenges and hugely affected daily life, especially in healthcare utilization [1,2]. United States studies report that healthcare utilization has significantly decreased during the time of the Covid-19 pandemic[3,4]. Hospital admissions for acute coronary syndrome and several other conditions have also significantly declined in the United Kingdom[5,6]. Similar reductions have been observed in several other countries as well[7-11]. The reduction in healthcare utilization could critically affect healthcare institutions by deepening financial losses and halting provision of healthcare services[12-14]. However, there have been few studies on how the Covid-19 pandemic affected small healthcare institutions due to the relatively short period of observational time.

Small healthcare institutions could be especially vulnerable to external impacts because their organizational and financial infrastructure is more fragile than that of large hospitals. One natural phenomenon we can frequently observe is that small things or organisms are more severely affected than larger ones by huge impacts from the same external changes. For example, smaller ships or vessels are more swayed by big waves than larger ships or vessels. Many drug companies conduct clinical trials with small organisms or animals because external effects can be easily observed or detected[15-17]. In the healthcare field, the financial sustainability and profitability of small-scale owner-managed hospitals and small hospitals measured by number of beds is generally speaking most likely to be at risk[18,19].

On the other hand, small healthcare institutions such as small hospitals and clinics play a crucial role in preventing disease and providing healthcare. They act as gatekeepers keeping communities safe, and are at the front line in the fight against disease. If the front line is broken due to lack of supplies or a worsening business eco-system, the impact on the population could be lethal and huge and result in market and governance failure[20] because people could not get any healthcare services[21-25]. Thus it is important to maintain their viability and a sufficient level of supply in the context of environmental change. This means that it is important to ask whether the Covid-19 pandemic has affected all healthcare institutions equally.

Given the short history of the Covid-19 pandemic, it is not surprising that there has not been a previous study of how the pandemic has affected healthcare in relation to the size of healthcare institutions. Only a few studies were reporting the field status of small medical practices experiencing the decline of clinics visits or revenue[26], but they were not adopting academic approaches. This study proposes the hypothesis that the Covid-19 pandemic has affected healthcare differently in terms of the size of healthcare institutions, and specifically, that smaller institutions have experienced significantly greater reductions in

utilization than larger institutions.

Resource dependence theory[27,28] may support our prediction. The theory generally explains organizational behavior or decision-making in terms of the organization's resource or power relationship with the external environment. Large hospitals in Korea have an advantage compared to small hospitals because most of their customers have serious conditions and have pre-arranged care schedules funded by the national insurance scheme, so that they have an assured demand. In Korea, patients can visit any primary care clinic without having any booking status[29]. A pandemic situation is likely to make patients averse to using healthcare unless their illness is serious. Thus, large healthcare institutions are more likely than smaller ones to have power controlling and stabilizing demand, so that they are less critically affected in terms of healthcare utilization. Hence if Covid-19 affects healthcare utilization, the decrease in healthcare utilization due to the pandemic will depend on the size of healthcare institutions. This study aims to verify this argument through the analysis of quantitative empirical national health insurance data. Theoretical concepts underpinning this study are: a 'power' measured by the 'size' a factor distinguishing types of healthcare institutions, and 'environmental impact' measured by 'changes in numbers of healthcare insurance claims' due to the Covid-19 pandemic.

Therefore, the objective of this study is to investigate the impact of Covid-19 on healthcare utilization across healthcare institutions of different sizes. If Covid-19 has critically affected small healthcare institutions, then our healthcare delivery system could collapse, and this could provide grounds for the government to support small healthcare institutions[30]. This study could provide a basis for plans to prevent such a collapse.

METHODS

Study design

This study adopted a simple retrospective study design comparing an outcome variable for each quarter in 2020 compared with the corresponding quarter in 2019. Many previous studies have adopted a similar design[31-33]. The units of analysis were individual healthcare institutions. There were four types of healthcare institutions in the study: tertiary hospitals (the final number included was 42), general hospitals (293), "hospitals" (referred to here as 'small hospitals' to clearly differentiate them from tertiary and general hospitals: 1,272), and clinics (27,049). These are the standard categories used for the administration of the national health insurance program.

Tertiary hospitals have specific characteristics including a large number of beds and association with a university college of medicine. General hospitals have more than 100

beds. In Korea, small hospitals differ from clinics in that they have 30 or more beds but less than 100 (except mental hospitals). Small hospitals and clinics perform a primary care gateway role. Clinics have less than 30 beds, and some have none at all. If clinics do not have any beds and provide healthcare to outpatients, then the reimbursement processing is filed as outpatient health insurance claims. If they provided healthcare using beds such as hospitalization, then the claim would be filed as inpatient health insurance claim. Thus, whether clinics have or do not have beds does not affect the outcome measure of this study because this study only considered outpatient health insurance claims. Since the four types of healthcare institution are defined in part by the number of beds, the number of beds was excluded as a variable from the main analysis model, though it was used in a secondary model of closure status.

Several previous studies have used outpatient visits as a healthcare use indicator[34,35]. This study used numbers of health insurance claims for outpatients to measure healthcare utilization, for reasons of simplicity and validity. One outpatient visit creates a claim, thus it is easy to observe and evaluate the extent of healthcare utilization by counting the number of claims. We only counted the actual number of outpatient visits during each year (2019, 2020). In order to compare institutions under normal operating conditions, this study excluded healthcare institutions which did not have any health insurance claims within a consecutive 3-month period.

Finally, this study received approval from the institutional review board (on March 17, 2021) (IRB number ID: 2021-036-001).

Data sources

This study used health insurance administrative data from the Health Insurance Review and Assessment Service (HIRA). HIRA is a third-party administrator running the national health insurance program in Korea and provides a professional health insurance review and assessment service for the program. As aforementioned, this study targeted all outpatient health insurance claims. The research team extracted all health insurance claims having a date of healthcare from January 1, 2019 to December 31, 2020. Healthcare insurance claims could be submitted long after the actual date that healthcare was provided. This study also included a guideline that review and assessment should be completed by June 30, 2021. According to an unpublished report and general observation by HIRA, 99.99% of health insurance claims are submitted within a 6-month period following the actual provision of healthcare. After extracting the health insurance claims, the claims were aggregated on a quarterly basis for each healthcare organization.

Outcome variables and independent variables

The main dependent variable was the number of outpatient health insurance claims in 2019

and 2020 as used in other studies[36]. This was used as a proxy measure of healthcare utilization. The number of health insurance claims in the two years was compared using four focal time points on a quarter(Q) basis: Q1, Q2, Q3 and Q4. The major independent variables were type of institution, location, and years of operation for each healthcare provider. A market competition measure was included: for hospitals, the Herfindahl-Hirschman Index[37] based on the number of beds; and for clinics, the number of competing clinics located nearby. Four types of healthcare institutions were studied. The actual number of beds reported to HIRA by healthcare organizations was only used for the secondary model to confirm the annual permanent closure status of healthcare institutions. Ownership (public or private) was only used for general hospitals and small hospitals because most other healthcare institutions are private or for-profit entities. Location was classified as urban if the facilities were located in an area having more than 100,000 residents and as rural if in an area with less than 100,000 residents. Years of operation refers to how many years each facility had been in operation.

Statistical analysis

This study first investigated the descriptive statistics of each healthcare organization in terms of facility size. Group t-tests were used for the numeric values of the main outcome variable: the number of health insurance claims. Before conducting the main analysis, the correlations among the independent variables were investigated, and those having high correlations were excluded from the main analysis in order to avoid multicollinearity in the regression analysis. The number of beds was closely associated with the type of healthcare institutions and so was excluded from the main analysis model. The Modified Park Test was used to determine family of distribution for the generalized linear models[38,39] and the test result suggested a Gamma distribution, which was applied for the model. Thus, the generalized linear models were constructed with link=log and distribution=gamma controlling all institutions' general characteristics. A secondary logistic regression was also conducted in order to see whether there was any significant permanent closure of healthcare institutions. This study used SAS version 9.4 (SAS Institute, Cary, NC, USA) for the data analysis.

Patient and public involvement

Patients and the public were not involved in this study.

RESULTS

General characteristics of the study subjects

Table 1 presents the general characteristics of study subjects. There were 42 tertiary hospitals, mostly in private ownership (71.4%) and located in an urban area (97.6%). There were 293 general hospitals mostly in private ownership (82.6%). Approximately 97 percent of small hospitals were private and most were located in an urban area (90.9%). Almost all the clinics were private (99.9%) and located in an urban area (93.7%), and 15.2% of clinics had inpatients beds.

Table 1. General characteristics of the study subjects (N = 28,656)

Size of Health Care institution	Variables	Mean or % (SD*)	Min	Max
Tertiary hospitals (N=42)	Years of operation	37.6 (15.6)	12	112
	Ownership: private, %	71.4	-	-
	Location: urban, %**	97.6	-	-
	Number of beds	1,084.2 (433.7)	684.0	2,715.0
	Herfindahl-Hirschman Index	2,006.8(1,146.0)	420.5	5,971.5
General hospital (N=293)	Years of operation	28.0 (12.9)	4.0	61.0
	Ownership: private, %	82.6	-	-
	Location: urban, %	94.2	-	-
	Number of beds	352.7 (181.8)	100.0	1003.0
	Herfindahl-Hirschman Index	1,476.9(1,176.6)	291.0	9,035.2
Small hospitals (N=1,272)	Years of operation	14.6(8.8)	2.0	76.0
	Ownership: private, %	96.6	-	-
	Location: urban, %	90.9	-	-
	Number of beds	110.7(79.9)	30.0	490.0***
	Herfindahl-Hirschman Index	1,416.2(1,246.1)	291.0	10,000.0
Clinics (N=27,049)	Years of operation	17.2(9.4)	2.0	63.0
	Ownership: private, %	99.9	-	-
	Location: urban, %	93.7	-	-
	Having beds, %	15.2	-	-
	Number of clinics nearby	8.9(10.1)	1.0	114.0

*SD: standard deviation; HHI: Herfindahl-Hirschman Index

**: Most institutions are located in urban areas, so this variable was excluded from the main analysis

***: including some mental hospitals having more than 100 beds

Changes in the number of health insurance claims

Table 2 shows the change in the number of health insurance claims in each quarter of 2020

compared with the corresponding quarter of 2019. On average, the number of outpatient health insurance claims decreased by 14.9%. The change was greatest in small hospitals (-16.8%) followed by clinics (-16.3%). The percentage changes for general hospitals and tertiary hospitals were -8.9% and -5.2%, respectively.

Table 2. Changes in health insurance claims between 2019 and 2020 (N = 28,933)

Size of HCI	Period	2019	2020	Change (%)	t-value	p-value
Average number of HIC	Year	25,112	21,372	-14.89	7.67	<0.0001
Tertiary hospitals (N=42)	Q1	254,060	236,972	-6.73	0.47	0.6423
	Q2	261,987	250,264	-4.47	0.30	0.7618
	Q3	270,386	254,865	-5.74	0.39	0.6952
	Q4	269,854	258,675	-4.14	0.28	0.7814
	Total	1,056,286	1,000,777	-5.26	0.36	0.7208
General hospitals (N=293)	Q1	61,466	56,866	-7.48	1.16	0.2479
	Q2	65,215	57,529	-11.79	1.86	0.063
	Q3	65,854	60,898	-7.53	1.18	0.2394
	Q4	65,764	59,993	-8.78	1.38	0.1691
	Total	258,299	235,285	-8.91	1.4	0.1626
Small hospitals (N=1,272)	Q1	11,730	10,332	-11.92	3.77	0.0002
	Q2	12,885	10,255	-20.41	6.71	<0.0001
	Q3	12,648	10,671	-15.63	5.08	<0.0001
	Q4	12,987	10,536	-18.87	6.10	<0.0001
	Total	50,250	41,794	-16.83	5.48	<0.0001
Medical clinics (N=27,049)	Q1	4,669	4,306	-7.77	12.58	<0.0001
	Q2	5,123	4,066	-20.62	35.08	<0.0001
	Q3	4,760	4,142	-12.98	21.21	<0.0001
	Q4	5,252	4,060	-22.69	38.67	<0.0001
	Total	19,803	16,574	-16.31	27.46	<0.0001

H: hospitals, C: clinics, M: medicine; HCI: health care institution, HIC: health insurance claim

Figure 1 presents the overall reduction in healthcare insurance claims and the reduction by type (size) of healthcare institution between the two years, respectively. The analysis clearly shows that the total number of health insurance claims from all healthcare institutions fell, and the magnitude of the reduction increased as the size of healthcare institutions decreased.

Here [Figure 1]. Total number of health insurance claims (2019, 2020)

Changes in health insurance claims after controlling institutional covariates

Table 3 presents the healthcare utilization in 2020 before and after controlling each healthcare institution's covariates. While the number of health insurance claims from small hospitals (Absolute risk (AR): 0.8317, 0.7758 to 0.8915, p<0.0001; Relative risk(RR): 0.8299, 0.7750 to 0.8888, p<0.0001) and clinics (AR: 0.8369, 0.8262 to 0.8478, p<0.0001; RR: 0.8362, 0.8255 to 0.8470, p<0.0001) significantly decreased, those of tertiary hospitals and general hospitals did not. The magnitude of the decrease in healthcare utilization was greatest in small hospitals, followed by clinics.

Table 3. Changes in Health Insurance Claims after Controlling Healthcare Institutional Covariates

Size of institution	Variables	Not controlling hospital covariates (Absolute risk)				Controlling hospital covariates (Relative risk)			
		Exp (β)	95% CI		p-value	Exp (β)	95% CI		p-value
			LL	UL			LL	UL	
Tertiary hospitals (N=42)	Years of operation					0.9975	0.9907	1.0043	0.4674
	Ownership: private (Ref = public)					0.9749	0.7716	1.2318	0.8316
	Herfindahl-Hirschman Index					1.0002	1.0001	1.0003	<.0001
	Observation time point: Year 2020 (Ref =2019)	0.9474	0.7518	1.1940	0.6474	0.9475	0.7672	1.1702	0.6170
General hospital (N=293)	Years of operation					1.0114	1.0070	1.0158	<.0001
	Ownership: private (Ref = public)					1.1922	1.0302	1.3796	0.0182
	Urban location (Ref = rural)					1.9585	1.4909	2.5731	<.0001
	Herfindahl-Hirschman Index					1.0000	1.0000	1.0001	0.3537
	Observation time point: Year 2020 (Ref =2019)	0.9109	0.8133	1.0202	0.1065	0.9104	0.8167	1.0148	0.0902
Small Hospitals (N=1,272)	Years of operation					1.0165	1.0122	1.0208	<.0001
	Ownership: public (Ref = private)					2.0228	1.6525	2.4761	<.0001
	Urban location (Ref = rural)					1.2685	1.0863	1.4811	0.0026
	Herfindahl-Hirschman Index					1.0000	1.0000	1.0001	0.1473
	Observation time point: Year 2020 (Ref =2019)	0.8317	0.7758	0.8915	<.0001	0.8299	0.7750	0.8888	<.0001
Clinics (N=27,049)	Years of operation					1.0009	1.0002	1.0016	0.0123
	Urban location (Ref = rural)					0.7837	0.7631	0.8048	<.0001
	Number of clinics nearby					0.9934	0.9928	0.9941	<.0001
	Observation time point: Year 2020 (Ref =2019)	0.8369	0.8262	0.8478	<.0001	0.8362	0.8255	0.8470	<.0001

β: regression coefficients of the generalized linear model for the number of health insurance claims; Exp is the exponential function; CI: confidence interval; LL stands for lower limit and UL stands for upper limit.

Impact of Covid-19 on the Closure of Healthcare Institutions

Table 4 presents factors associated with the permanent closure of healthcare institutions between 2019 and 2020. The analysis shows that there was no significant difference in the number of operating healthcare institutions between the two years. This means that the Covid-19 pandemic did not cause the permanent closure of healthcare institutions.

Table 4. Factors associated with the permanent closure of healthcare institutions with time points before and after the onset of the Covid-19 pandemic

Size of institution*	Variables	Adjusted OR	95% CI		p-value
			LL	UL	
General hospital* (N=2019: 323 2020:329)	Years of operation	0.947	0.906	0.988	0.0130
	Number of beds	0.994	0.989	0.999	0.0256
	Herfindahl-Hirschman Index	1.001	1.000	1.001	<.0001
	Observation time point: 2020 (Ref =2019)	1.041	0.383	2.829	0.9372
Small Hospitals (N=2019: 1,583; 2020:1,603)	Years of operation	0.961	0.941	0.981	0.0001
	Ownership: public(Ref = private)	0.998	0.996	1.000	0.1129
	Number of beds	1.521	0.552	4.192	0.4173
	Herfindahl-Hirschman Index	1.001	1.000	1.001	<.0001
	Observation time point: 2020 (Ref =2019)	0.905	0.655	1.249	0.5421
Clinics (N=2019:33,545; 2020:34,268)	Years of operation	0.986	0.981	0.99	<.0001
	Having beds (Ref=no beds)	1.246	1.114	1.393	0.0001
	Ownership: public(Ref = private)	2.832	0.703	11.409	0.1432
	Number of clinics nearby location	1.004	1.001	1.007	0.0084
	Observation time point: 2020 (Ref =2019)	1.063	0.976	1.157	0.1592

* OR: odds ratio; CI: confidence interval; LL stands for lower limit and UL stands for upper limit; there were no permanent closure events in tertiary hospitals; Excluded variables not having any closure events.

DISCUSSION

This study investigated the impact of Covid-19 on healthcare institutions, especially focusing on small healthcare institutions compared with larger ones. Healthcare utilization was measured by the number of outpatient health insurance claims. Healthcare utilization in the year 2020 was significantly lower by 14.9% compared with 2019. The magnitude of decrease in healthcare utilization was greatest in small hospitals and clinics. However, the decreases for large hospitals (tertiary and general hospitals) were smaller and not significant. In summary, the magnitude of the reduction in healthcare utilization increased as the size of institutions decreased. These findings were not due to any increase or

decrease in permanent closure of hospitals during the time of the Covid-19 pandemic.

These results were aligned with other studies in which most researchers report decreases in healthcare utilization[3,6,8]. In terms of magnitude of decrease, this study found that overall healthcare utilization decreased by 14.9%. According to a study conducted in the United States, overall office visits during the period from March 15 to June 20 decreased by nearly 40% compared to the previous months of 2020[40]. A study conducted in the United Kingdom shows a decrease of 27% comparing outpatient visits from early March to late October 2020 with the same period of the previous year[41]. Although the decline in healthcare utilization may not be directly comparable because each study had different time periods and data sources, the extent of decrease in Korea appears to have been slightly lower than those in other countries. This can be explained as due to governmental actions. To a greater extent than many other countries, the Korean government had implemented organized actions to control the Covid-19 pandemic such as mandatory mask-wearing, coordination of Covid-19 case management, providing Covid-19 diagnostic test kits, introducing telemedicine, and so on[42,43], which might have limited the decrease in healthcare utilization. Large hospitals in Korea also had effective plans for managing Covid-19 and maintaining safe healthcare services to patients[44,45].

In this study, the largest change was observed at small hospitals and clinics compared to large hospitals. This study result is exactly what we expected and one academically verifying some of field experiences and observations[26]. What can explain this? It is argued here that small facilities are particularly sensitive to the external environment. In the Korean healthcare system, large hospitals may have invisible advantages compared to small hospitals in their institutional rules and practices. In terms of medical demand, patients cannot access tertiary hospitals without referral from primary care clinics or a record of previous hospital visits, making it unlikely that patients visiting large hospitals would stop attending. These institutional rules and practices in the healthcare delivery system would result in little reduction in outpatient visits to tertiary hospitals and general hospitals. Large hospitals have characteristics that mean they are not easy to temporarily close due to the COVID-19 pandemic, because they have many employees and maintenance costs compared to small hospitals and clinics. In contrast, small hospitals and clinics could more easily be closed temporarily because they do not have many employees and they have lower operating costs, and this would lead to lower healthcare utilization.

Limitations

This study has several limitations. First, this study only used a two-year comparison ignoring earlier years. This fact may result in some internal validity issues caused by ignoring previous long-term trends or some confounding factors. Although this study used

all the outpatient health insurance claims, the large sample size does not guarantee high internal validity, but increases the statistical power. If this study had included previous years' trends, then the study could have had more accurate results. Second, healthcare utilization is strictly speaking different from the number of health insurance claims. The number of actual visits, medical costs or inpatient hospitalizations would be good examples of healthcare utilization. But this study used the number of health insurance claims as a proxy measure for healthcare utilization. Finally, the interpretation of study results may be limited to Korea because many countries have different healthcare systems. Further research could overcome these limitations.

Study implications

This study has importance from several perspectives. First, this study used all the health insurance claims at the national level covering more than fifty million people. The study results were also based on a hypothesis and organisational theory. Thus, the study has produced a validated figure for the decrease in healthcare utilization due to Covid-19 in Korea as a whole. Second, the study has provided a new finding that the magnitude of changes in healthcare utilization in Korea increases as the size of healthcare institution decreases. There has been little study on this issue in Korea. Third, the study deals with small healthcare institutions such as small hospitals and clinics. Although they play an important role in our communities preventing infectious diseases, there has been a lack of research focusing on how they are affected by the Covid-19 pandemic. Government could take appropriate political action by using our results to support these institutions in times of pandemics such as Covid-19. The results could contribute to developing a sustainable healthcare delivery system through governmental support. Fourth, this study identified that there was relatively less reduction of healthcare utilization in Korea compared to other nations. Considering the high population density in Korea, the relatively small reduction in healthcare utilization stands as an achievement of the Korean government in the management of healthcare systems. A national level figure for the reduction in healthcare utilization provides a representative benchmark for comparison with other countries. Finally, this study raises a question as to whether the study findings are generalizable to other nations and provides an opportunity to test the study findings. We argue that each nation has its own categories of healthcare facilities and, thus, there would be a very low possibility of having the exactly same research settings. However, there are some similarities between Korea and other Asian countries, especially Taiwan and Japan. For example, medical facilities called "clinics" in Korea, Taiwan, and Japan are ones run by 1 to 5 physicians and some of them may have beds in all three countries. There are also tertiary hospitals in Taiwan although the size and specific definition of the tertiary hospitals is

different from that in Korea[46,47]. The definition of "clinics" and "hospital" in Japan is almost the same as that in Korea[48]. Thus, this study provides an opportunity to other nations or international colleagues to test whether environmental impacts such as the Covid-19 pandemic affect healthcare institutions differently depending on the size of those institutions.

CONCLUSION

This study has verified that there was a significant decrease in healthcare utilization in Korea during the time of Covid-19 pandemic compared to the previous year, which is aligned with other studies on healthcare utilization. However, the magnitude of change increases as the size of healthcare institutions decreases. The greatest decrease occurred at small hospitals followed by medical clinics. This study raises a political question of how to support these small healthcare institutions at the time of an infectious disease pandemic and whether healthcare in small healthcare institutions is really non-essential. But given that small clinics and hospitals are important and it is clear that they are affected by environmental factors, it follows that healthcare policy makers need to pay more attention to whether there could be gaps in the provision of everyday healthcare.

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Contributors: YTP conceptualised the study and design. YTP and HJL retrieved and analyzed the data. YTP, CL, HJL, and JHL contributed to data interpretation. YTP and CL wrote the first draft of the manuscript. YTP, CL, HJL, and JHL reviewed and edited the first draft and significantly contributed to the manuscript. All authors have read and agreed to the published version of the manuscript.

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Competing interests: None declared.

Patient and public involvement: Patients and/or the public were not involved in the design, or conduct, or reporting or dissemination plans of this research.

Patient consent for publication: Not applicable.

Ethics approval: The study was approved by the Institutional Review Board of Health Insurance Review and Assessment Service (HIRA) in Korea (IRB number: 2021-036-001).

Provenance and peer review: Not commissioned; externally peer reviewed

Data availability statement: Data may be obtained from a third party and are not publicly available. The data are healthcare institution's organizational characteristics and the number of monthly outpatient health insurance claims in each healthcare institution from January 1, 2019 to December 31, 2020. Because of the sensitive nature of the data collected for this study, requests to access the dataset may be sent to the Health Insurance Review and Assessment Service (HIRA) in Korea and the data may be obtained from the HIRA upon reasonable request.

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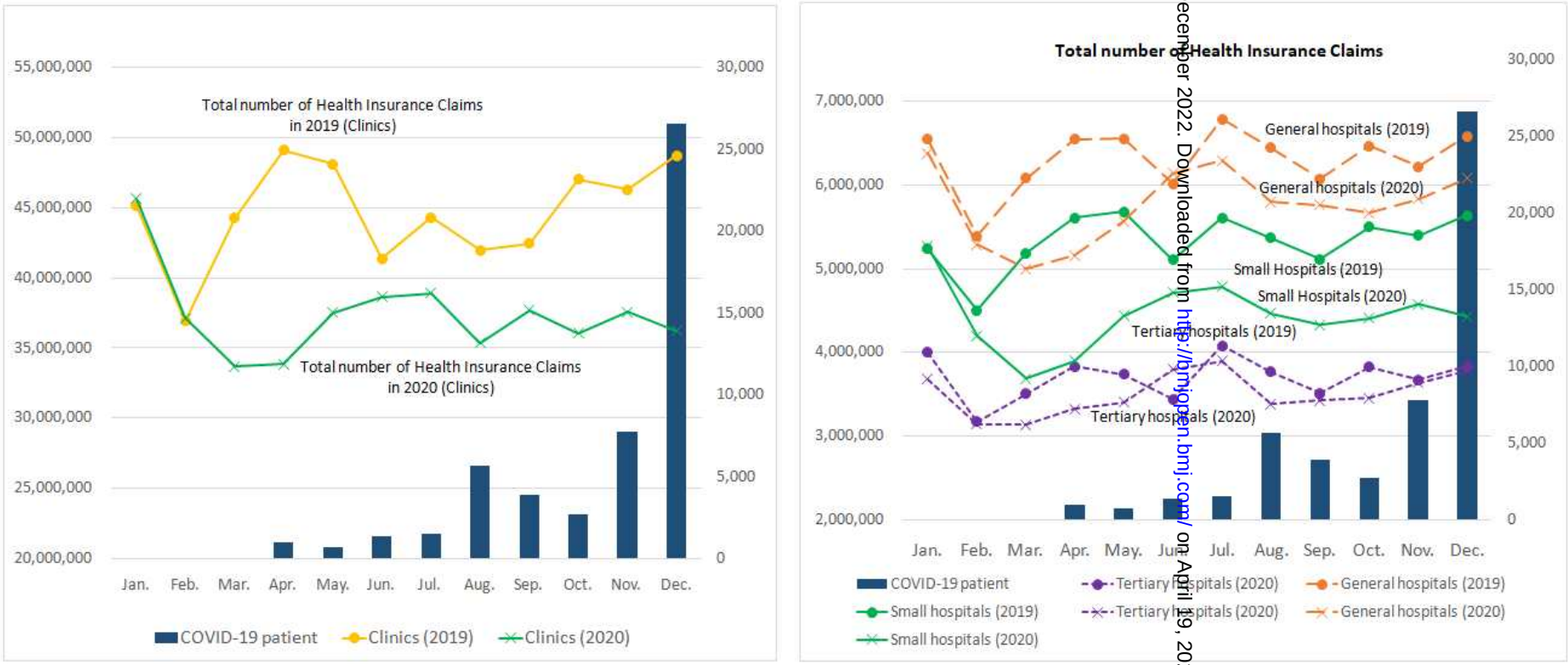

Figure 1. Total number of health insurance claims (2019, 2020)

STROBE Statement—Checklist of items that should be included in reports of ***cross-sectional studies***

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4, 5
Objectives	3	State specific objectives, including any prespecified hypotheses	4, 5
Methods			
Study design	4	Present key elements of study design early in the paper	5
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5,6 7
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants	6, 7
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6,7
Data sources/measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6*
Bias	9	Describe any efforts to address potential sources of bias	6,7
Study size	10	Explain how the study size was arrived at	5
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	6,7
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7
		(*b*) Describe any methods used to examine subgroups and interactions	7
		(*c*) Explain how missing data were addressed	7
		(*d*) If applicable, describe analytical methods taking account of sampling strategy	7
		(*e*) Describe any sensitivity analyses	-
		Results	
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	8
		(b) Give reasons for non-participation at each stage	-
		(c) Consider use of a flow diagram	-
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	8
		(b) Indicate number of participants with missing data for each variable of interest	8
Outcome data	15*	Report numbers of outcome events or summary measures	8,9
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	10,11

		(*b*) Report category boundaries when continuous variables were categorized	8
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	11,12
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	-
Discussion			
Key results	18	Summarise key results with reference to study objectives	11
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	12,13
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	11,12, 13
Generalisability	21	Discuss the generalisability (external validity) of the study results	13
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	14

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.