



The Impact of COVID-19 on National Disease Dynamics: Population-based Interrupted Time Series Study in South Korea

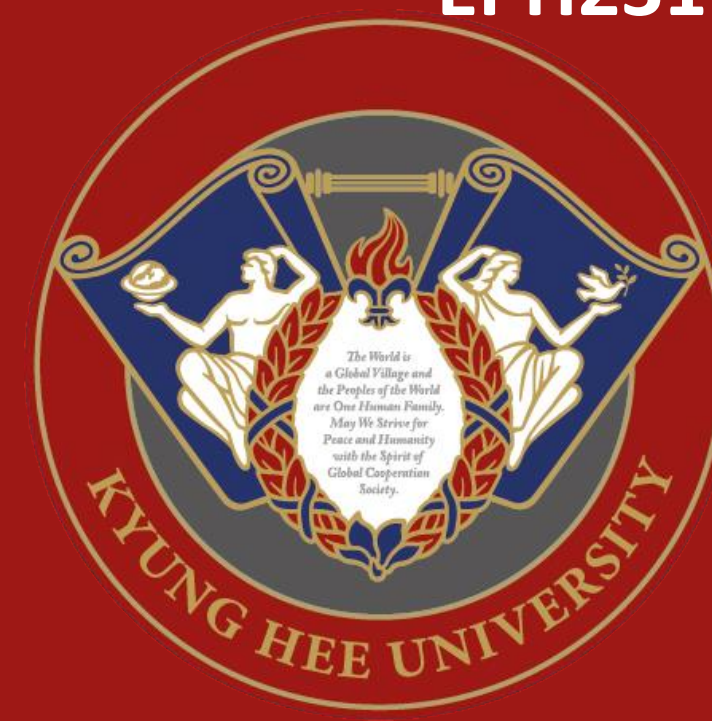
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INTRODUCTION

- Amidst the ongoing COVID-19 pandemic, the global disease dynamics have been impacted by the COVID-19 disease itself and the implementation of various policies, including lockdown.
- The repercussions of these influences are expected to persist beyond the immediate aftermath of the pandemic, with potential implications for future outbreaks of similar nature.
- In this study, our objective is to investigate the impact of COVID-19 on national disease dynamics.

METHODS

- Study design: Interrupted time series analyses
- Data source
 - The Health Insurance Review & Assessment Service Open data from January 2010 to August 2022 in South Korea (national insurance open data from South Korea).
- Covariates (marginal slope coding)
 - Time (month, integer): 1, 2, 3, ... 152 (from January 2010 to August 2022)
 - COVID-19 (dummy variable): 0 (before January 2020), 1 (after January 2020)
 - Interaction term – COVID-19 * time: 0, 1, 2, 3, ... 31 (time after COVID-19 from January 2020 to August 2022)
 - Omicron (dummy variable): 0 (before January 2021), 1 (after December 2021)
 - Interaction term – Omicron * time: 0, 1, 2, 3, ... 8 (time after Omicron from December 2021 to August 2022)
- Outcome
 - The number of monthly patients primarily diagnosed with 2,085 diseases categorized according to three-character ICD-10 disease codes (A00 – Z99).

Disease Code	Name
A00	Cholera
A01	Typhoid and paratyphoid fevers
A02	Other salmonella infections
A03	Shigellosis
...	...
C48	Malignant neoplasm of retroperitoneum and peritoneum
C49	Malignant neoplasm of other connective and soft tissue
C50	Malignant neoplasm of breast
...	...
I26	Pulmonary embolism
I27	Other pulmonary heart diseases
I28	Other diseases of pulmonary vessels
...	...
J43	Emphysema
J44	Other chronic obstructive pulmonary disease
J45	Asthma
...	...
Z97	Presence of other devices
Z98	Other postsurgical states
Z99	Dependence on enabling machines and devices, NEC

- Statistical analysis
 - Models for 2,085 diseases
 - Generalized linear square regression (GLS) with AR1 model accounting for autoregression
- $$Y = \alpha + \beta_1 * \text{Time} + \beta_2 * \text{COVID} + \beta_3 * \text{COVID} * \text{Time} + \beta_4 * \text{Omicron} + \beta_5 * \text{Omicron} * \text{Time} + \epsilon_j$$
- β_2 : immediate impact on monthly patients for COVID-19 by diseases
 - β_3 : sustained impact on monthly patients for COVID-19 by diseases
 - β_4 : immediate impact on monthly patients for Omicron by diseases
 - β_5 : sustained impact on monthly patients for Omicron by diseases
 - Impact of COVID-19 on a specific disease:
 - Significant positive impact of COVID-19: defined as $\beta_2 > 0$ & $\beta_3 > 0$ (β_2 , β_3 p-value < 0.05)
 - Significant negative impact of COVID-19: defined as $\beta_2 < 0$ & $\beta_3 < 0$ (β_2 , β_3 p-value < 0.05)
 - Significant positive impact of Omicron: defined as $\beta_4 > 0$ & $\beta_5 > 0$ (β_4 , β_5 p-value < 0.05)
 - Significant negative impact of Omicron: defined as $\beta_4 < 0$ & $\beta_5 < 0$ (β_4 , β_5 p-value < 0.05)

ACKNOWLEDGEMENT

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This research was supported by a grant (21153MFDS601) from the Ministry of Food and Drug Safety in 2023.

RESULTS

- A comprehensive analysis was conducted on a total of 2,085 ICD-10 three-character disease codes.
- Of these, 1,669 diseases were claimed in South Korea during the period spanning January 2010 to August 2022.
- A total of 1,649 ITS models were rigorously analyzed, ensuring that all models exhibited robust non-singularity and successful convergence.
- Significant positive and negative impacts on diseases

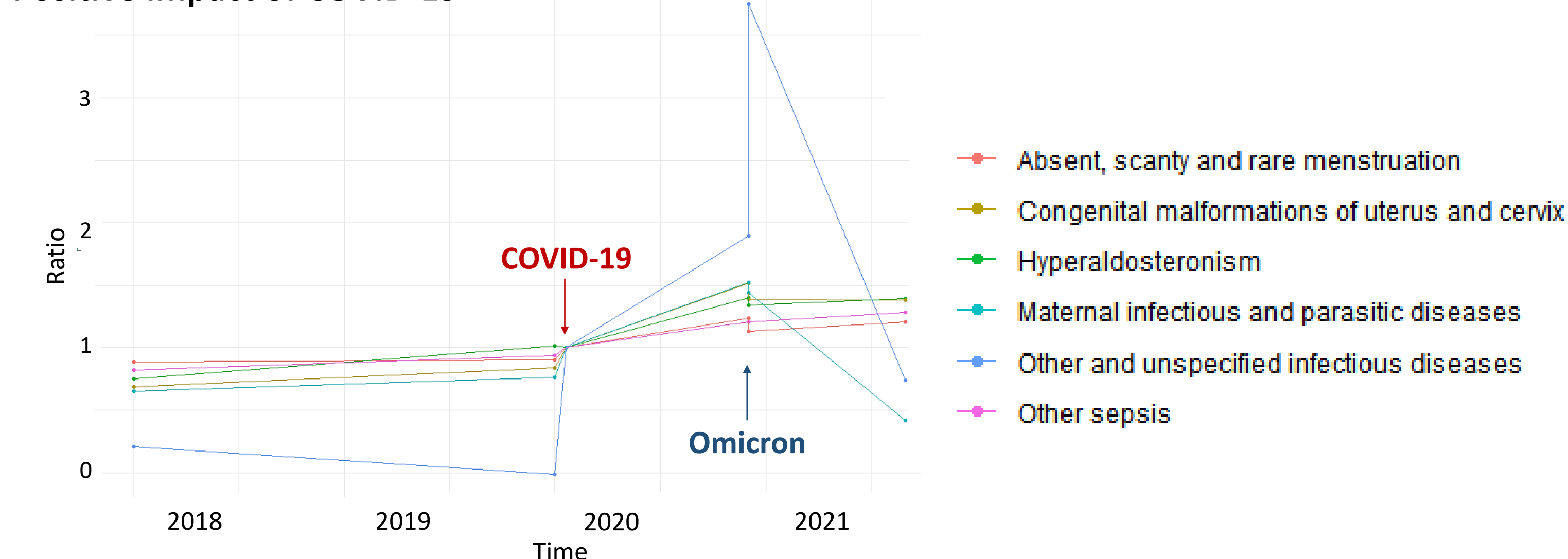
	Positive impact	Negative impact
COVID-19	- Absent, scanty, and rare menstruation - Congenital malformations of uterus and cervix - Hyperaldosteronism - Maternal infectious and parasitic diseases classifiable elsewhere but complicating pregnancy, childbirth and the puerium - Other and unspecified infectious diseases - Other sepsis	- Abnormal findings in specimens from male genital organs - Acute pancreatitis - Birth injury to skeleton - Congenital hydrocephalus - Cushing's syndrome - Diseases of Bartholin's gland - Disturbances of smell and taste - Failure and rejection of transplanted organs and tissues - Female pelvic inflammatory disorders in diseases classified elsewhere - Foreign body in genitourinary tract - Human immunodeficiency virus diseases resulting in other conditions - Neonatal aspiration syndromes - Other diseases caused by chlamydiae - Other disorders of optic nerve and visual pathways - Other nontraumatic intracranial haemorrhage - Other osteochondropathies - Paraplegia and tetraplegia - Placenta praevia - Polyarteritis nodosa and related conditions - Schizoaffective disorders - Spontaneous rupture of synovium and tendon - Streptococcus and staphylococcus as the cause of diseases classified to other chapter
Omicron	N/A	- Mental disorder NOS (not otherwise specified) - Haemorrhage, NEC (note elsewhere classified) - Persons encountering health services in other circumstances

- The diseases classified as positive COVID-19 impact on the number of monthly patients were “absent, scanty and rare menstruation”, “congenital malformations of uterus and cervix”, “hyperaldosteronism”, “maternal infectious and parasitic disease”, “other and unspecified infectious disease”, and “other sepsis” ($p < 0.05$).
- The diseases classified as negative COVID-19 impact on the number of monthly patients were 22 diseases including “acute pancreatitis”, “failure and rejection of transplanted organ”, “Cushing's syndrome”, “paraplegia”, “schizoaffective disorders”, “disturbances of smell and taste”, and “streptococcus and staphylococcus as the cause of diseases classified to other chapters” ($p < 0.05$).

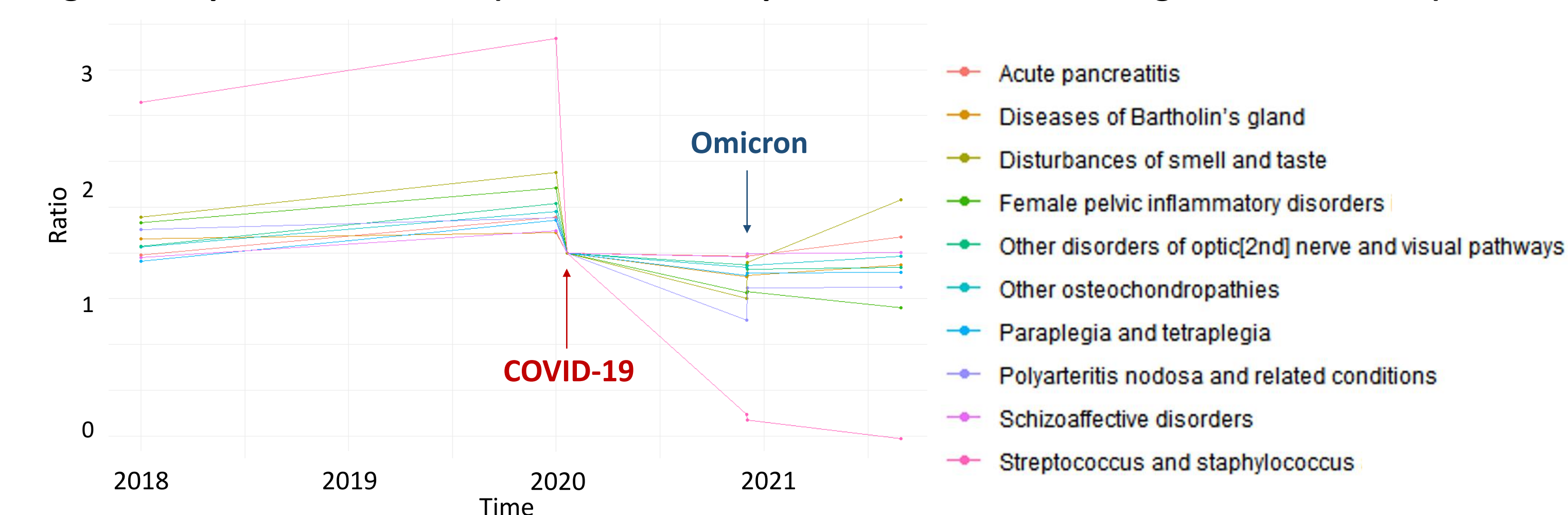
Impact of COVID-19 on diseases

(Line plot, Y axis represents ratios transformed from fitted Y in ITS model)

Positive impact of COVID-19



Negative impact of COVID-19 (Identified the top 10 diseases with the highest coefficients)



CONCLUSIONS

- The impact of COVID-19 on diseases is influenced by factors such as direct virus effects and policy measures. Diseases negatively associated with COVID-19 may be influenced by policies that hinder access to medical services.
- Consequently, patients with negative impact diseases may not seek hospital care regardless of the severity of symptoms, suggesting a potentially unfavorable prognosis for affected individuals in the future.
- These findings highlight the need for careful consideration of clinical strategies and policy interventions to mitigate the adverse effects of future pandemics.*** By leveraging the knowledge gained from this study, we hope to develop more effective and targeted policies in anticipation of future outbreaks.