Changes in Mortality Rate Distribution and Associated Regional Factors at the Neighborhood Level in Seoul, South Korea: A Comparative Analysis of Pre- and Post-COVID-19

P3-G13

Joonsu Jang[1,2], Kisiju Trishna[1,2], Soojung Kim[2,3], Nawon Kim[2,3], and Byung Chul Chun[1,2,3]
[1]Korea University Graduate School, Seoul, South Korea, [2]Korea University College of Medicine, Seoul, [3]Graduate school of Public Health, Korea University, Seoul

- **South Korea's age-standardized mortality rate (SMR) has steadily declined through 2021 despite the COVID-19 pandemic, but in Seoul, the country's capital, it has increased since the pandemic.**
- **The increase in SMR during the COVID-19 pandemic in Seoul varied widely by neighborhood.**
- **Hot spots of SMR during the COVID-19 pandemic were found in neighborhoods with low education levels and limited healthcare resources, while affluent neighborhoods that were cold spots before the pandemic remained cold spots.**
- **In policies to protect people's health and prevent deaths during a pandemic like COVID-19, regional prioritization and re-allocation of healthcare resources are essential.**

BACKGROUND

- Seoul is the capital of South Korea and is a metropolis of 9.6 million people covering an area of 605.2 km^2. (Pop. Density: 15,93/ km^2)
- South Korea's mortality rates have decreased since 2012. However, Among the 17 provinces nationwide, Seoul is the only province where mortality rates have increased after COVID-19.

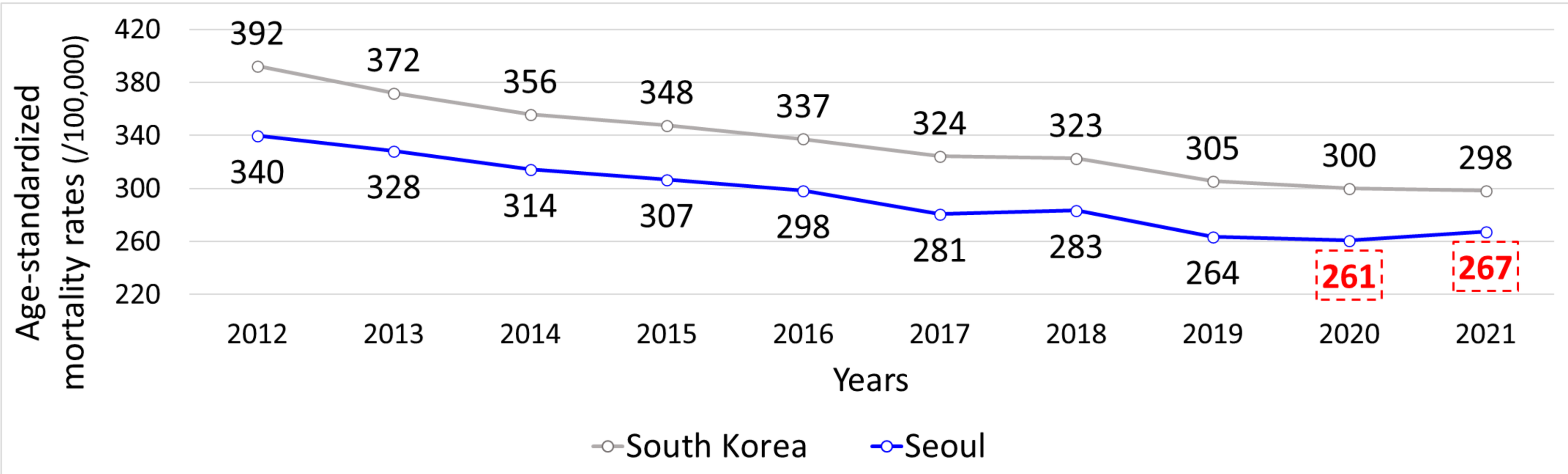

Figure 1. Age-standardized mortality rate (per 100,000 people) in South Korea and Seoul

- **We aims to explore neighborhood-level mortality rates changes pre-/post-COVID-19 in Seoul using spatial clustering and to investigate regional factors affecting mortality rates differences.**

METHODS

- Study variables
  - Standardized mortality rates (in 2019 and 2021)
  - Crude mortality rate difference: pre-/post-COVID-19 difference
- Study area: 425 neighborhoods (dong) in Seoul, South Korea
- Study period: 2019 and 2021 (pre-/post-COVID-19)

Description of study variables

Table 1. List of study variables

Variables	
Outcome variables	
	Standardized mortality rates, 2019 & 2021 Crude mortality rate difference (difference between 2019 and 2021)
Explanatory variables	
Socioeconomic variables	Divorce (%) 2019 Single-person household (%), 2019 Low education attainment (%), 2020 High education attainment (%), 2020 Elderly population (%), 2019 Basic living security recipients (%), 2019 Elderly living alone (%), 2019
Healthcare related variables	Health facilities per 100 people, 2017 Medical doctors per 100 people, 2017

Statistical analysis

Spatial analysis

- Spatial autocorrelation test: Global Moran's I statistics
- Getis-Ord Gi* clustering: To detect the high-risk areas
- Bayesian spatial analysis
  - iCAR† and BYM‡ model
  - Performed using INLA**

The difference in mortality rates per Dong i (i=1,…,425) can be represented as Y_i, using a **BYM model** as follows:

$$Y_i \sim N(\mu_i, \sigma^2_i) \text{ where, } E(Y_i) = \mu_i \text{ and } V(Y_i) = \sigma^2_i$$

$$\mu_i = \alpha + \sum_k (\beta_k \times variables_{i,k}) + s_i + \varepsilon_i$$

$$s_{1:425} \sim iCAR(W, \sigma_s^2)$$

$$\varepsilon_i \sim N(0, \sigma_\varepsilon^2)$$

where,
Y_i = differences in mortality rate of Dong i
μ_i = mean of Y_i
σ_i^2= variance of Y_i
α= intercept
β_k= regression parameters of each variable k
s_i= intrinsic conditional auto-regressive term
ε_i= random effect quantifying non-spatial variation

*AIC: akaike information criterion,
†iCAR: intrinsic conditional auto-regressive model,
‡BYM: Besag-York-Mollie model,
**INLA: integrated nested Laplace approximation

RESULTS

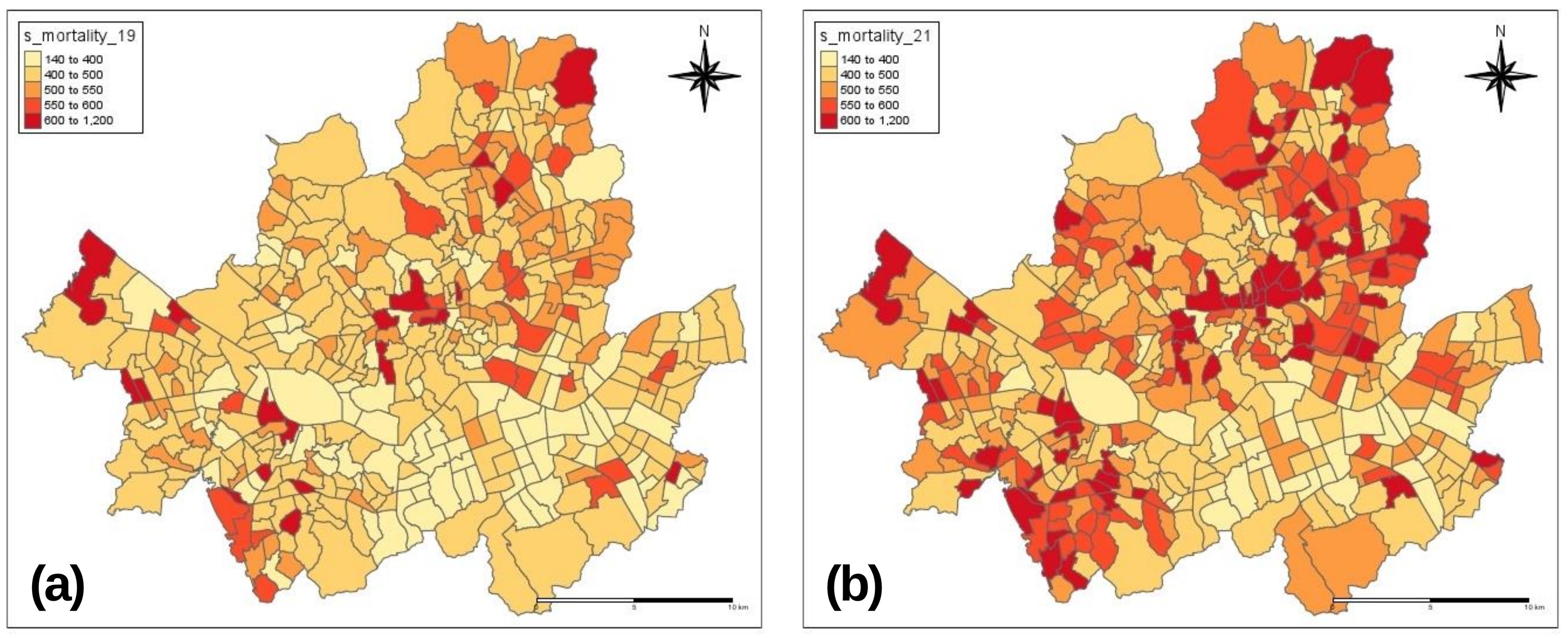

Figure 2. Regional distribution of age-standardized mortality rates (per 100,000 people) in 2019 (a) and 2021(b) in Seoul Hot Spot clusters Cold Spot clusters

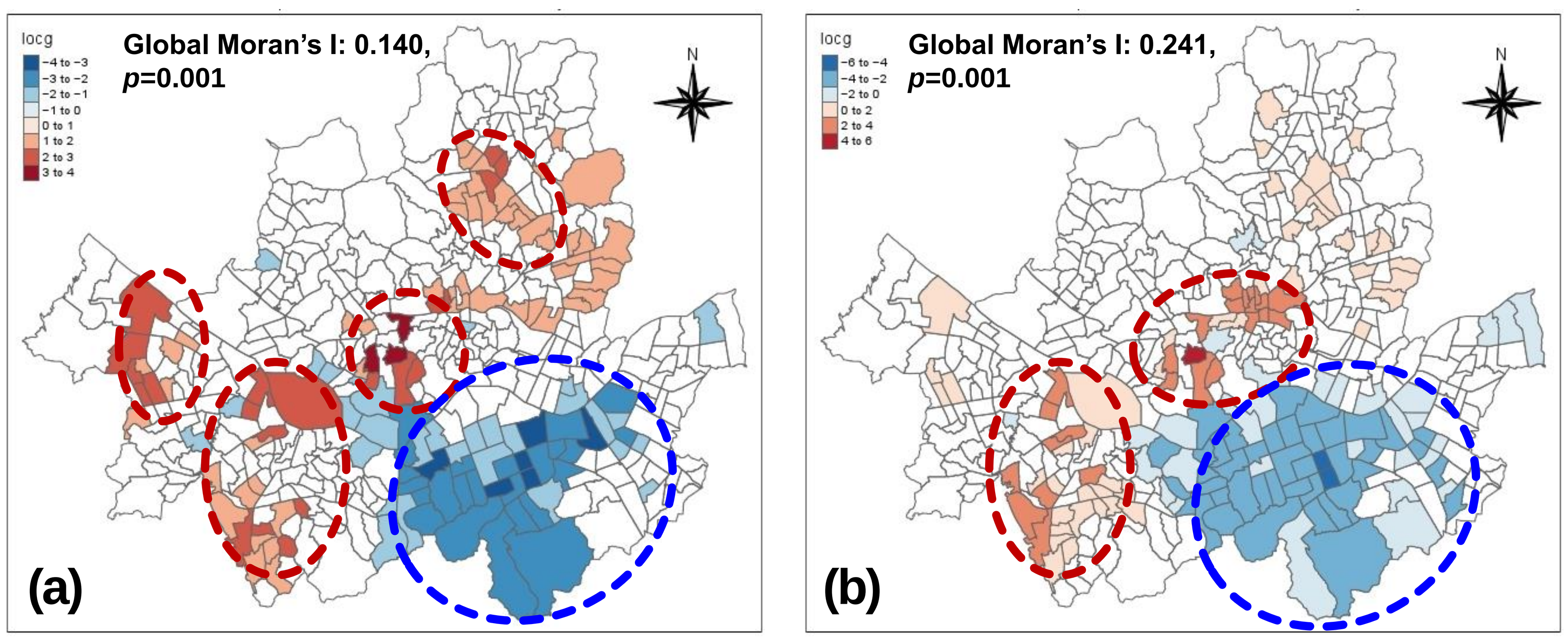

Figure 3. Getis-Ord Gi* clustering of age-standardized mortality rates (per 100,000 population) in 2019 (a) and 2021 (b) in Seoul

Table 2. Results of regional factors at the neighborhood-level for mortality rate difference, expressed as coefficients (95% credible interval).

Variables	Spatial model	
	iCAR	BYM
Divorce (%)	6.1 (-52.1, 64.3)	14.6 (-37.9, 67.0)
Single-person household (%)	1.6 (0.5, 2.7)	**1.6 (0.9, 2.2)**
Low education attainment (%)	1.3 (-0.6, 3.2)	**1.3 (1.1, 2.4)**
High education attainment (%)	1.9 (-1.7, 5.5)	1.9 (-0.2, 4.0)
Elderly population (%)	7.3 (2.9, 11.8)	**7.4 (4.8, 10.0)**
Basic living security recipients (%)	1.1 (-3.8, 6.0)	1.2 (-1.7, 4.0)
Elderly living alone (%)	-3.0 (-10.9, 5.0)	-3.0 (-7.6, 1.7)
Health facilities (per 100 people)	2.2 (-20.5, 25.0)	2.3 (-11.6, 16.2)
Medical doctors (per 100 people)	-10.0 (-16.0, -4.0)	**-10.1 (-13.6, -6.5)**
DIC*	4,972	**2,197**

*DIC: deviance information criterion

CONCLUSION

- Seoul's SMR increased overall during COVID-19, with significant regional variations in the increase.
- Factors associated with regional increases in SMR during the COVID-19 pandemic are low educational attainment, a high proportion of elderly people, a high proportion of households living alone, and a low number of physicians relative to the population.
- This study highlights the importance of identifying high-risk areas for mortality at the neighborhood level, which directly contributes to setting public health policy priorities.

ADDITIONAL KEY INFORMATION

- All authors have no conflict of interest to declare
- Contact:: chun@korea.ac.kr, c16329@korea.ac.kr

WCE WORLD CONGRESS OF EPIDEMIOLOGY 2024