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ARTICLE

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Trends of new diagnosis and treatment initiation of hypertension during the COVID-19 pandemic in Korea

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Abstract

The COVID-19 pandemic has broadly disrupted healthcare utilization, potentially affecting the diagnosis and treatment of hypertension. While most reports focus on countries with strict lockdowns, the impact on care in countries like South Korea that did not impose lockdowns remains unclear. This study aimed to investigate the changes in trends of new diagnosis and treatment initiation of hypertension in Korea during the pandemic. Using Korean nationwide claims data from 2015 to 2020, we identified new diagnosis and treatment initiation of hypertension. New diagnosis was defined as a claim for essential hypertension (International Classification of Diseases-10 code: I10), and treatment initiation was defined as a hypertension claim with antihypertensive prescription. Age-standardized rates were calculated using the 2020 insured population. Monthly trends in 2020 were compared with 2019 and with projected rates estimated using autoregressive integrated moving average (ARIMA) models based on pre-pandemic trends from 2015 to 2019. Analyses were conducted at the national and subnational levels. From 2015 to 2019, the rates of new diagnosis and treatment initiation of hypertension increased steadily, but both decreased in 2020. The most pronounced monthly decrease occurred in March 2020, with the largest regional declines observed in Daegu and Gyeongbuk. In the ARIMA model analysis, the observed rates in March 2020 were approximately 21% lower than expected rates for new diagnosis and 18% lower for treatment initiation. A substantial decline in new diagnosis and treatment initiation of hypertension was observed during the early phase of the COVID-19 pandemic in Korea.

Keywords COVID-19 · Health Services · Hypertension · Pandemics

Introduction

The COVID-19 pandemic has profoundly impacted societies and healthcare systems worldwide. The pandemic led to a significant decline in hospital visits globally, affecting various aspects of healthcare utilization, including inpatient, outpatient, and emergency department visits [1–3]. This disruption in healthcare was not limited to acute conditions but also extended to the management of chronic diseases such as hypertension [4].

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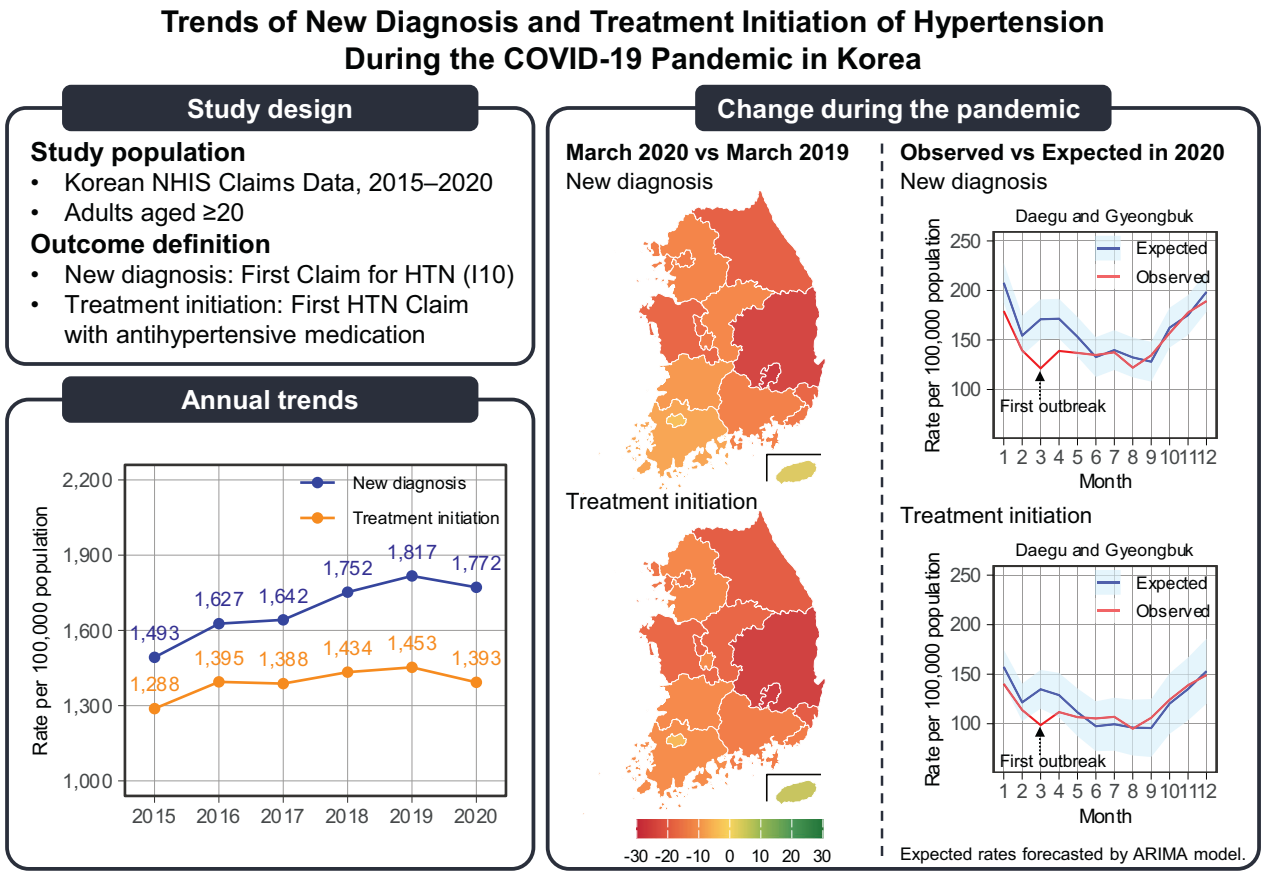
Graphical Abstract



Point of view

- Clinical relevance: This nationwide study revealed a substantial decline in new diagnosis and treatment initiation of hypertension during the COVID-19 pandemic, suggesting a sustained disruption in hypertension management that may increase the future cardiovascular disease burden.
- Future direction: Long-term surveillance and research are essential to assess the long-term impact of the pandemic and develop public health strategies to re-engage patients in routine care.
- Consideration for the Asian population: Proactive regional monitoring and management strategies are essential to address the hidden burden of undiagnosed hypertension across Asia and to mitigate future cardiovascular risks.

Such disruptions are a critical public health concern, as delays in the diagnosis and treatment of hypertension can lead to prolonged periods of uncontrolled blood pressure (BP), subsequently increasing the risk of major cardiovascular events like myocardial infarction and stroke [5, 6].

In South Korea, nationwide health screening programs and universal access to primary care have contributed to high awareness and treatment rates for hypertension (BP ≥ 140/90 mmHg or on antihypertensive medication), reaching 77% and 74% in 2022 [7]. These systems have enabled the early identification and effective management of hypertension throughout the population. However, substantial reductions in health screening participation and outpatient healthcare utilization were observed during the pandemic, raising concerns that the diagnosis and treatment of hypertension may also have been adversely affected [8, 9].

Indeed, studies from the United Kingdom and Spain have documented substantial decreases in newly diagnosed hypertension during the COVID-19 pandemic [10, 11]. However, these findings originate largely from regions that implemented mandatory national lockdowns, which physically restricted access to primary care [12]. It remains less clear how trends in newly diagnosed hypertension were affected in healthcare systems without such stringent

lockdowns. South Korea presents a unique setting to investigate this question, with its universal single-payer healthcare system that ensures high accessibility and a pandemic response that centered on mass testing and contact tracing rather than nationwide shutdowns of primary care facilities [13].

Using the National Health Insurance Service (NHIS) database, this study aimed to investigate trends in the new diagnosis and treatment initiation of hypertension in Korea, comparing the pre-pandemic period from 2015 to 2019 with the COVID-19 pandemic period of 2020.

Materials and methods

Data source and study population

We used a nationwide Korean database of NHIS. As a single provider of mandatory health insurance for the country, the NHIS covers approximately 97% of the entire Korean population. The NHIS database includes socio-demographic information and reimbursement claims with diagnosis codes based on the International Classification of Diseases, 10th revision (ICD-10) [14]. Further details on the NHIS database are available elsewhere [15, 16]. This study included adults aged ≥20 years from 2015 to 2020.

This study was approved by the Institutional Review Board of Yonsei University College of Medicine (No. 2-2021-0058) and was conducted in accordance with the Declaration of Helsinki. Informed consent was waived since this is a retrospective study of deidentified administrative data.

Ascertainment of new diagnosis and treatment initiation of hypertension

New diagnosis of hypertension was defined as a health insurance claim for essential hypertension (ICD-10 codes: I10), and treatment initiation as a corresponding claim accompanied by an antihypertensive medication prescription [7]. Antihypertensive medications included angiotensin receptor blockers, angiotensin converting enzyme inhibitors, calcium channel blockers, diuretics (thiazide and related diuretics, loop diuretics, potassium-sparing diuretics), beta-blockers, and others (alpha-blockers, vasodilators, etc.) [7]. To ensure that only new cases were identified, a washout period was applied by confirming that participants had no prior claims for hypertension since 2002.

Geographical units

Korea comprises 17 first-tier administrative divisions, including 8 metropolitan cities and 9 provinces. In this study, each participant's region was determined based on their resident registration address. The analyses were performed at two geographical levels: nationwide and subnational (across the 17 administrative divisions). For the clarity of regional trend, the 17 divisions were further aggregated into 9 broader regions according to geographical proximity (Seoul; Incheon and Gyeonggi; Gangwon; Daejeon, Sejong, and Chungcheong [Chungbuk and Chungnam]; Gwangju and Jeolla [Jeonbuk and Jeonnam]; Daegu; Gyeongbuk; Busan, Ulsan, and Gyeongnam; Jeju).

Statistical analysis

Participant characteristics were presented as median [interquartile range] or number (%). The annual and monthly rates for new diagnosis and treatment initiation of hypertension were calculated as the number of new cases per 100,000 population. Age-standardized rates were calculated using the direct standardization method, with the 2020 insured population as the standard. To compare the temporal relationship between the pandemic and its impact, monthly COVID-19 incidence rates for 2020 were calculated using monthly confirmed cases provided by the Korea Disease Control and Prevention Agency (KDCA) and 2020 estimated population data [17].

To evaluate changes in trends during the COVID-19 period (defined as the year 2020), two analytical approaches were used. First, direct year-over-year comparisons with 2019 were conducted. For each month, we calculated the absolute difference, the cumulative difference (the sum of absolute differences from January to the given month), and the percentage change from the previous year. Second, expected rates for 2020 were forecasted using an autoregressive integrated moving average (ARIMA) model, trained on pre-pandemic trends from 2015 to 2019 [18, 19]. Parameters for the ARIMA model were determined using the 'auto.arima' function in the 'forecast' package for R [20]. The observed rates for 2020 were then compared to the expected rates and corresponding 95% confidence intervals (CIs).

A sensitivity analysis was conducted by repeating the entire analysis using outpatient claims only. All statistical analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC, USA) and R version 4.0.3 (R Foundation for Statistical Computing, Vienna, Austria).

Results

Trends of new diagnosis and treatment initiation of hypertension

Over the study period, a total of 4,364,358 adults were newly diagnosed with hypertension, and 3,605,135 initiated

Table 1 Participant characteristics of newly diagnosed hypertension and antihypertensive treatment initiation

Variables	Newly diagnosed hypertension ($N = 4,364,258$)	Antihypertensive treatment initiation ($N = 3,605,135$)
Age, years	54 [45–62]	54 [46–63]
Sex		
Male	2,465,084 (56.5)	2,062,025 (57.2)
Female	1,899,174 (43.5)	1,543,110 (42.8)
Household income*		
Q4, highest	1,303,194 (29.9)	1,069,151 (29.7)
Q3	1,105,000 (25.3)	916,221 (25.4)
Q2	887,319 (20.3)	733,828 (20.4)
Q1, lowest	1,001,917 (23.0)	832,502 (23.1)
Unknown	66,828 (1.5)	53,433 (1.5)
Residential area		
Metropolitan	1,825,374 (41.8)	1,507,590 (41.8)
Urban	1,603,173 (36.7)	1,321,328 (36.7)
Rural	932,334 (21.4)	773,143 (21.4)
Unknown	3,377 (0.1)	3,074 (0.1)
Year		
2015	626,791 (14.4)	540,930 (15.0)
2016	690,800 (15.8)	592,254 (16.4)
2017	704,331 (16.1)	595,294 (16.5)
2018	760,030 (17.4)	621,804 (17.2)
2019	798,039 (18.3)	638,136 (17.7)
2020	784,267 (18.0)	616,717 (17.1)

Q, quartile

Values as median [interquartile range] or number (%)

*Categorized based on quartiles among the entire Korean population

antihypertensive treatment. Among newly diagnosed adults and those initiating treatment, the median age was 54 years in both groups. The proportion of males was 56.5% and 57.2%, respectively (Table 1).

The annual crude rates of new diagnosis and treatment initiation of hypertension increased from 2015 to 2019 and subsequently decreased in 2020 (Fig. 1). Specifically, from 2019 to 2020, the rate of new diagnosis decreased from 1817 to 1772 per 100,000 population, and the rate of treatment initiation decreased from 1453 to 1393 per 100,000 population. This pattern was observed in both males and females, though the rate of increase was more pronounced among males (Fig. 1).

Comparison of monthly trends between 2020 and 2019

Compared to the previous year, the monthly age-standardized rates of new diagnosis and treatment initiation of hypertension were generally lower nationwide through May 2020. This trend was observed across all regions except Jeju, with the most pronounced decrease occurring in March 2020, which temporally corresponded to the peak of the first wave of the COVID-19 pandemic (Fig. 2 and Supplementary Tables 1, 2). Nationwide, the percentage change in March 2020 from March 2019 showed a 14.1% decrease in new diagnosis of hypertension and a 14.7% decrease in treatment initiation (Supplementary Tables 1–2). This decline in March was evident in all regions except Jeju and was most significant in Daegu and Gyeongbuk (Fig. 3 and Supplementary Tables 1, 2).

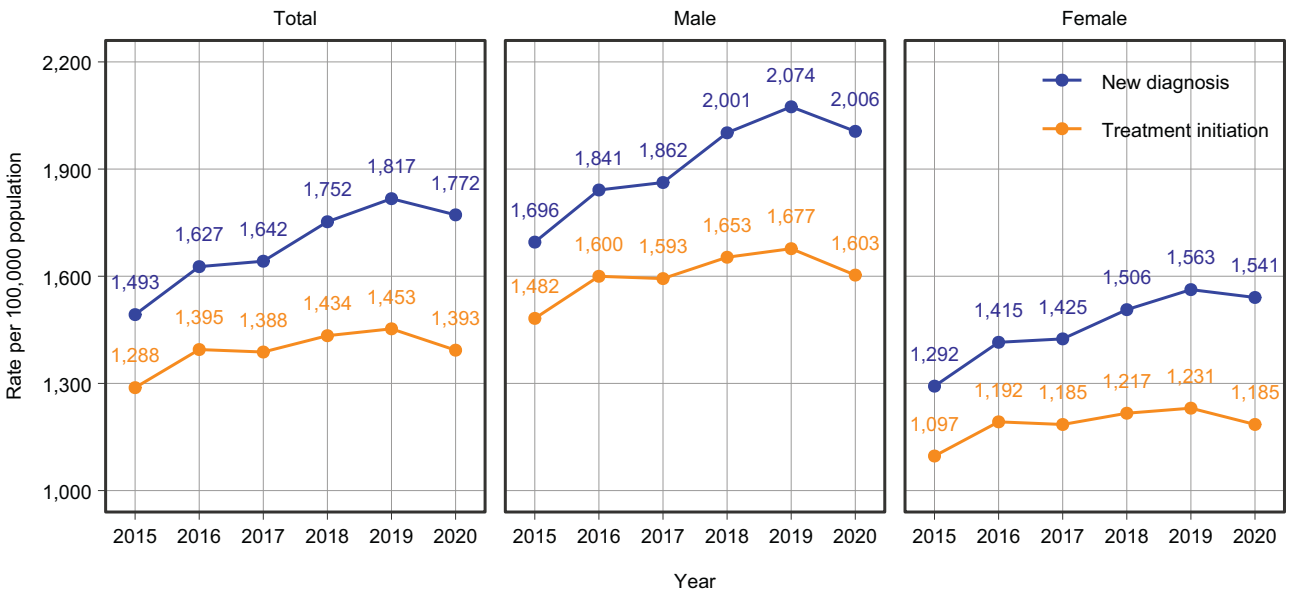


Fig. 1 Annual crude rates of new diagnosis and treatment initiation of hypertension, 2015–2020. Rates are presented for the total population and stratified by sex

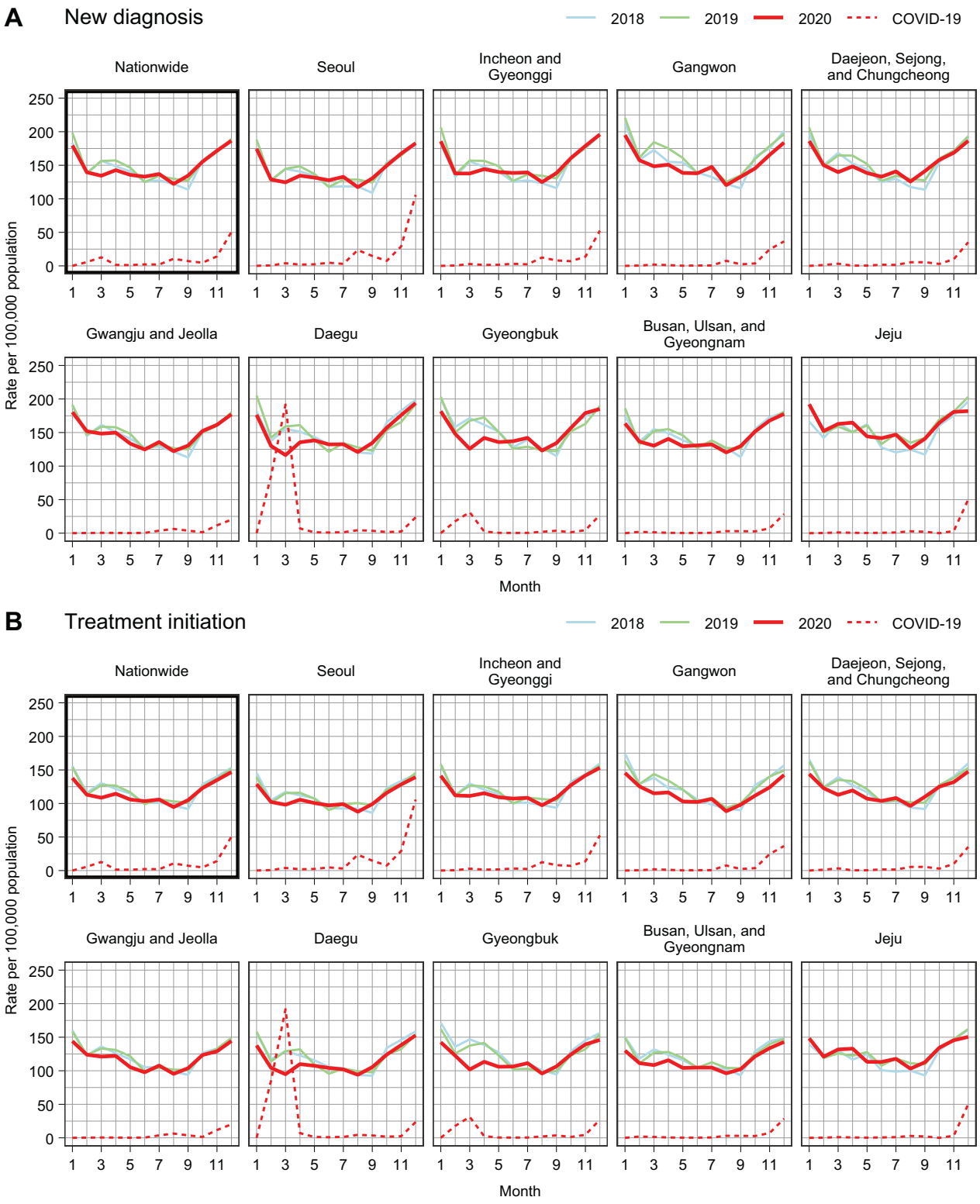


Fig. 2 Monthly age-standardized rates of new diagnosis (**A**) and treatment initiation (**B**) of hypertension for nationwide and 9 regions, 2018–2020. Age-standardized rates were calculated using the 2020 insured population as the standard population. For comparison, monthly COVID-19 incidence rates for 2020 were also presented

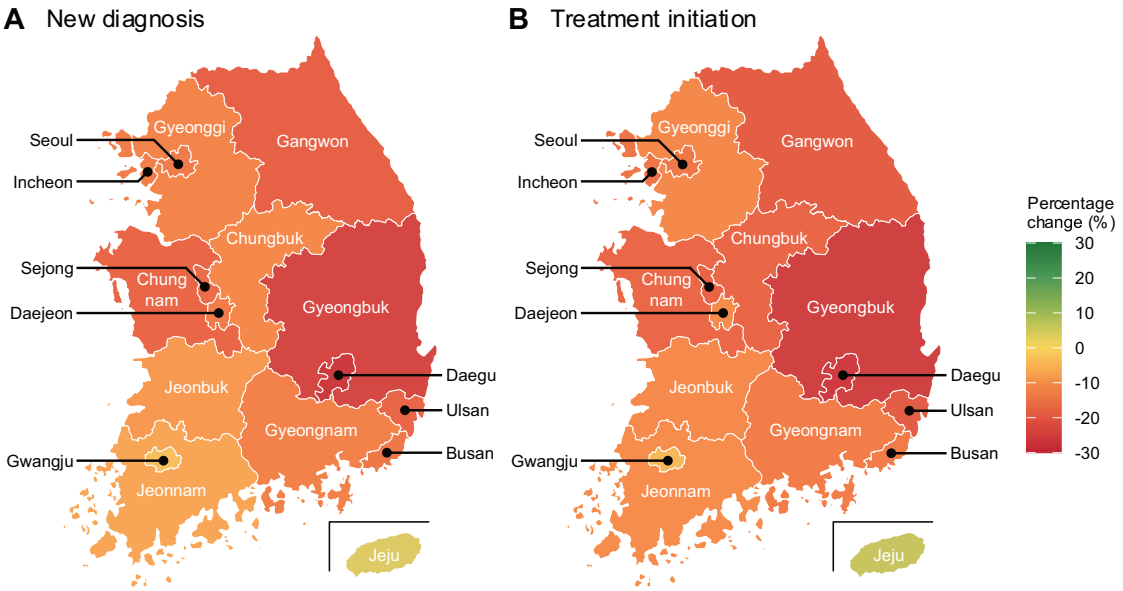


Fig. 3 Percentage change in age-standardized rates of new diagnosis (**A**) and treatment initiation (**B**) of hypertension in March 2020 compared to March 2019 across 17 administrative divisions. Age-standardized rates were calculated using the 2020 insured population as the standard population. Percentage change was calculated as: [(rate in March 2020 - rate in March 2019) / rate in March 2019] × 100

The nationwide cumulative difference in monthly age-standardized rates between 2020 and 2019 generally became more negative through May, after which it plateaued for both new diagnosis and treatment initiation of hypertension. This pattern of negative cumulative difference was consistent across all regions except Jeju. Through June 2020, the cumulative difference was most pronounced in Gangwon, Gyeongbuk, and Daegu (Fig. 4 and Supplementary Tables 1, 2).

Comparison of observed and expected trends in 2020

In the analysis using the ARIMA model on the monthly age-standardized rates, the expected rates were generally higher than the observed rates for both new diagnosis and treatment initiation of hypertension for most months in 2020. The gap between the expected and observed rates was largest in March. During this month, the nationwide observed rates (New diagnosis, 134 per 100,000 population; Treatment initiation, 109 per 100,000 population) fell significantly below the lower bound of the 95% CI of the expected rates (Expected rate [95% CI] for new diagnosis, 171 [155–186] per 100,000 population; Expected rate [95% CI] for treatment initiation, 132 [117–146] per 100,000 population). This pattern was consistent across all regions except Jeju. The gap between expected and observed rates in March was most pronounced in Daegu and Gyeongbuk. In contrast, observed rates in Jeju remained within the 95% CI of the expected rates for all months in 2020 (Fig. 5).

In a sensitivity analysis restricted to outpatient claims, the overall rates of new diagnosis and treatment initiation of hypertension also declined in 2020. The decrease was most pronounced in March and in Daegu and Gyeongbuk, showing a spatiotemporal pattern consistent with that observed in the main analysis (Supplementary Figs. 1–4).

Discussion

This nationwide study revealed a notable decrease in new diagnosis and treatment initiation of hypertension during 2020, in contrast to the increasing trend observed from 2015 to 2019. The most substantial monthly reduction was observed in March 2020, with Daegu and Gyeongbuk regions experiencing the greatest decline. When projecting the expected trend based on pre-pandemic data from 2015 to 2019, the observed rates in March 2020 fell below the lower bound of the 95% CI. These findings indicate substantial disruption in hypertension detection and initial management coinciding with the COVID-19 pandemic onset.

The first wave of the COVID-19 pandemic in Korea was centered in Daegu, where the initial case was reported on February 18, 2020 [21]. This was soon followed by an

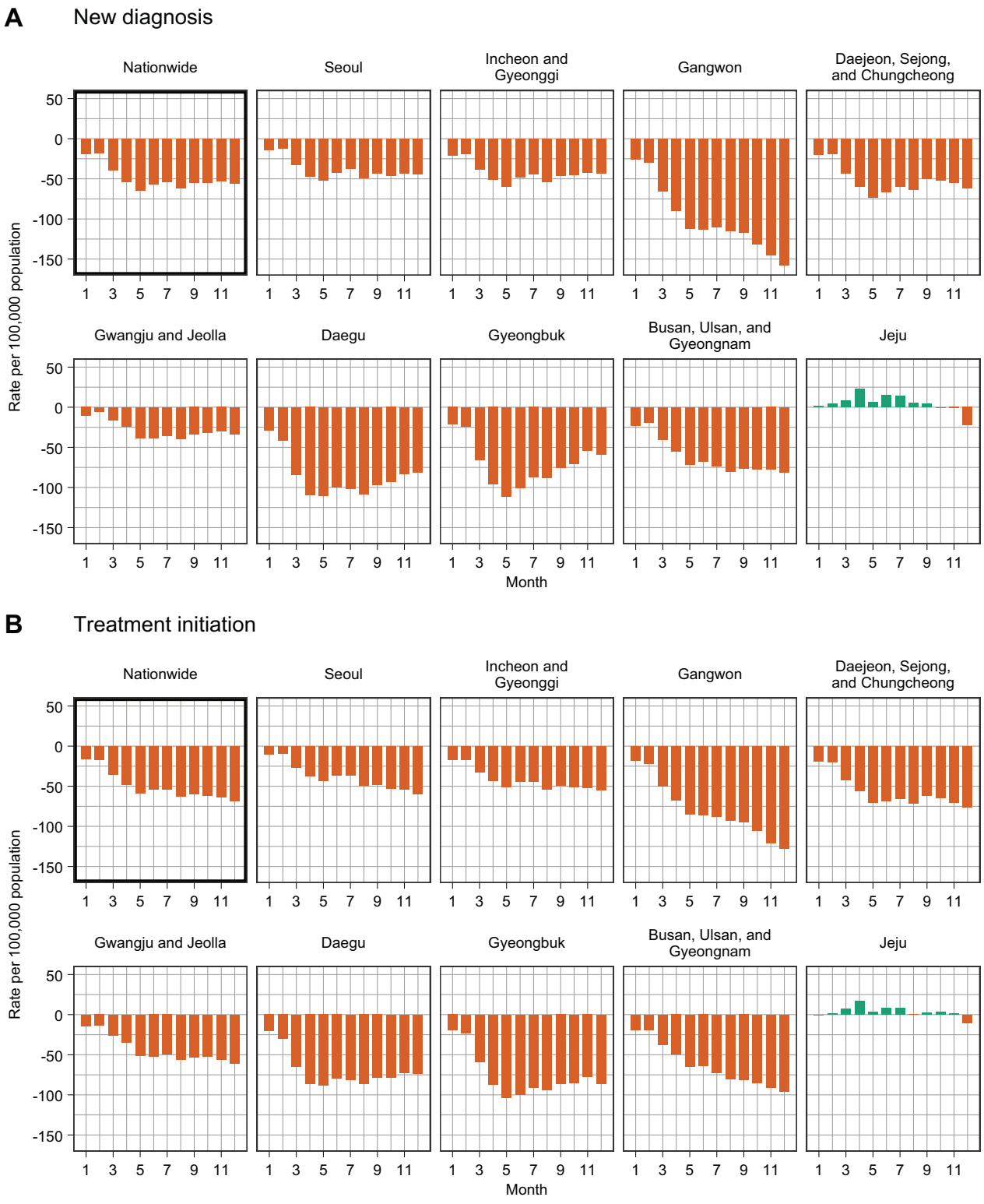


Fig. 4 Cumulative difference in monthly age-standardized rates of new diagnosis (**A**) and treatment initiation (**B**) of hypertension between 2020 and 2019 for nationwide and 9 regions. Age-standardized rates were calculated using the 2020 insured population as the standard population

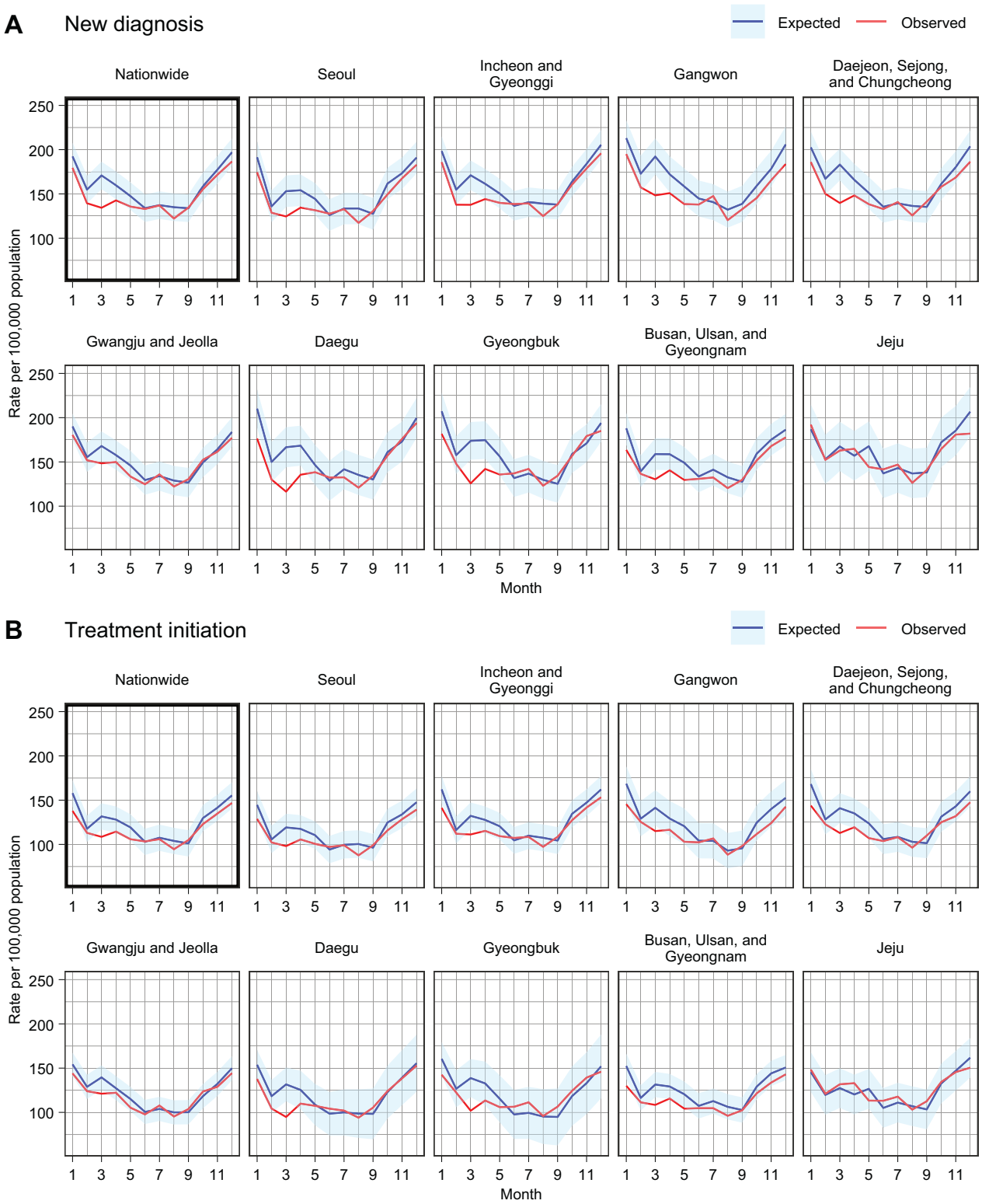


Fig. 5 Observed and expected monthly age-standardized rates of new diagnosis (**A**) and treatment initiation (**B**) of hypertension in 2020. Age-standardized rates were calculated using the direct standardization method, with the 2020 insured population as the standard population. Expected rates and corresponding 95% confidence intervals (blue shaded areas) were forecasted using an autoregressive integrated moving average model, trained on data from 2015 to 2019

explosive increase in infections, with cumulative cases in the Daegu region surpassing 6000 by the end of March [22, 23]. This rapid surge in COVID-19 cases caused widespread public fear and a nationwide decline in healthcare utilization [8, 24, 25]. The reduction in service use was most pronounced in Daegu, the epicenter of the outbreak [24]. Consistent with this pattern, our study found a marked decrease in the rate of new diagnosis and treatment initiation of hypertension in March 2020, with the decline being most pronounced in the Daegu and Gyeongbuk regions. Conversely, the Jeju region did not show a significant decrease in the new diagnosis and treatment initiation of hypertension during the first wave. This exceptional pattern may be attributed to the low incidence of COVID-19 cases during that period and its geographical isolation from the main epicenter. Given these regional variations, regions most affected during epidemic waves may face a greater long-term cardiovascular burden, as the delayed or missed diagnoses of hypertension increase the risk of future cardiovascular events [5, 6, 26]. Targeted and intensive management efforts are therefore needed for these high-risk areas to mitigate adverse outcomes associated with disruptions in chronic disease care.

Hypertension is often asymptomatic, and many individuals become aware of their condition through BP measurements during health screenings. In South Korea, national health screenings are conducted biennially for all adults aged 20 and over, with participation rates generally observed to be higher around March and at the end of the year [16]. Our study found that the monthly trends in newly diagnosed hypertension before the pandemic appeared to align with these peak screening periods, underscoring the role of national health screenings as one of the key route for detecting hypertension. However, during the COVID-19 pandemic, participation in these screening programs declined substantially nationwide, which may have contributed, at least in part, to the observed reduction in new diagnoses and treatment initiations of hypertension [9, 27]. Therefore, promoting and maintaining strong participation in health screening programs is important to address the accumulation of undiagnosed cases and to reduce the risk of adverse cardiovascular outcomes associated with delayed diagnosis.

Similar reductions in newly diagnosed hypertension were observed in other countries during the early phase of the COVID-19 pandemic. However, the magnitude of the decline varied considerably across countries. For example, studies from Spain and the United Kingdom, both of which implemented strict nationwide lockdowns, reported decreases in newly diagnosed hypertension of 40 percent and 65 percent, respectively [10, 11]. In contrast, the reduction observed in this study was less pronounced, with the rate of newly diagnosed hypertension in March 2020 approximately 21 percent lower than expected trend. This difference may be explained by South Korea's pandemic response, which prioritized widespread testing, contact tracing, and targeted isolation measures instead of enforcing a nationwide lockdown [13, 28]. Despite these efforts to maintain healthcare access, a comparable decline in new diagnosis and treatment initiation of hypertension still occurred in Korea. This finding highlights the pervasive impact of the pandemic on healthcare-seeking behavior, even in countries that avoided large-scale shutdowns of their healthcare systems.

Our analysis of cumulative differences in new diagnosis and treatment initiation rates suggests that the decline observed during the pandemic had not recovered by the end of 2020. This raises concerns about the potential long-term impact of the pandemic, as evidence from previous epidemics such as Severe Acute Respiratory Syndrome, shows that the disruption to healthcare utilization can persist for more than two years without a full recovery [29]. On the other hand, a cohort study through 2023 reported a significant increase in the incidence of new-onset hypertension during and after the pandemic period [30]. These two possibilities, namely a prolonged underdiagnosis due to reduced healthcare utilization and a genuine rise in disease incidence, highlight the need for continued monitoring and further research to fully understand the lasting impact of the COVID-19 pandemic on hypertension care.

A key strength of this study is the use of a nationwide claims database from a single-payer health insurance system, which enabled comprehensive identification of nearly all cases of hypertension diagnosis and treatment in Korea. However, several limitations should be acknowledged. First, although a marked decline in new diagnosis and treatment initiation was observed, the study design cannot determine the specific mechanisms through which the COVID-19 pandemic contributed to this decline. Nonetheless, the temporal alignment and regional variation suggest a plausible link to pandemic-related healthcare disruptions. Second, this analysis was limited to data up to 2020 and did not capture subsequent effects in healthcare utilization. While this restricts interpretation of long-term consequences, the analysis of cumulative rate differences provides meaningful insight into the persistence of the initial deficit. Finally, the generalizability of these findings may be limited in other countries due to heterogeneity in healthcare system structures, population characteristics, and pandemic response strategies.

Perspective of Asia

While South Korea's strategy focused on maintaining access to healthcare without a nationwide lockdown, our findings demonstrate that such efforts were insufficient to

prevent a significant decline in new diagnoses of hypertension. Given that many other Asian countries faced similar or even more restrictive circumstances, these countries likely faced a comparable hidden burden of undiagnosed hypertension even without formal lockdowns. Therefore, proactive regional monitoring and management strategies are needed to address the accumulated deficit in hypertension care across Asia and to mitigate future cardiovascular risks.

Conclusion

In conclusion, new diagnoses and treatment initiations of hypertension in Korea, which had been increasing from 2015 to 2019, declined substantially in 2020 during the COVID-19 pandemic. This decrease was most pronounced in March and in regions heavily affected by the first wave of the pandemic. These findings suggest a potential burden of delayed diagnosis of hypertension, highlighting the need for public health strategies to re-engage patients in routine care. Furthermore, given the potential for sustained disruption in hypertension care, long-term surveillance is essential.

Data availability

Because of the sensitive nature of the data collected for this study, requests by qualified researchers to access the dataset may be sent to the NHIS at https://nhiss.nhis.or.kr.

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Author contributions HCK and HL conceptualized and designed the study. JL, AL, MS, and HL conducted statistical analyses. All authors interpreted the findings. JL and AL drafted the manuscript. HCK and HL critically revised the manuscript for important intellectual content. All authors approved the final version of the manuscript.

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Compliance with ethical standards

Conflict of interest SCY reports grants from Daiichi Sankyo. SCY is a chief executive officer of PHI Digital Healthcare. Other authors have no conflicts of interest to declare.

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