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Socioeconomic Disparities by Health Insurance Type during the COVID-19 Pandemic: A Nationwide Study

Running title: Socioeconomic Disparities during COVID-19

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ABSTRACT

Objectives: To explore socioeconomic disparites by using health insurance type as a proxy, during the ongoing COVID-19 pandemic.

Methods: We conducted a retrospective cohort study using South Korea's nationwide healthcare database that contained all individuals who received a diagnostic test for COVID-19 (n=232,390) as of May 15, 2020. We classified our cohort by health insurance type into beneficiaries of the national health insurance (NHI) or Medicaid programs. Our study outcomes were infection with SARS-CoV-2 and COVID-19-related outcomes, a composite of all-cause death, intensive care unit admission, and mechanical ventilation use. We estimated the age, sex, and Charlson comorbidity index score adjusted odds ratio (aOR) with 95% confidence intervals (CIs) using a multivariable logistic regression analysis.

Results: Of the 218,070 NHI and 14,320 Medicaid beneficiaries who received COVID-19 tests, 7,777 and 738 tested positive, respectively. Medicaid beneficiaries were older (mean age 57.5 years versus 47.8), males (47.2% versus 40.2%), and had higher comorbidity burden (mean CCI 2.0 versus 1.7) than NHI beneficiaries. Compared to NHI, Medicaid beneficiaries were associated with a 22% increased risk of SARS-CoV-2 infection (aOR 1.22, 95% CI 1.09-1.38), but had a null association for COVID-19-related outcomes (aOR 1.10, 95% CI 0.77-1.57); individual events of the composite outcome yielded similar findings.

Conclusion: As socioeconomic factors, proxied by health insurance, could serve as determinants during the current pandemic, pre-emptive support is needed for high-risk groups to retard its spread.

Keywords: COVID-19, socioeconomic disparities, health insurance type

INTRODUCTION

Socioeconomic inequalities are one of the prominent reasons for health disparities,[1, 2] as their gap may profoundly impact the incidence of disease and its treatment, ultimately exacerbating health inequality.[3] Thus, many counties have a sub-system within their health insurance program, such as Medicaid, in which the government provides financial support depending on the subject's income or socioeconomic status. However, it remains uncertain as to whether these systems help mitigate health disparities or disease incidence among beneficiaries, especially during times of economic or epidemic crises.

With mounting evidence on the socioeconomic status associated with disease incidence,[4-6] subjects residing in deprived environments had higher prevalence of infectious diseases than their counterparts.[7, 8] In South Korea, the number of health insurance claims for noncommunicable diseases per Medicaid beneficiaries (low-income families; i.e., individuals eligible for the National Basic Living Security Act) were nearly quadruple than national health insurance beneficiaries.[9] Beneficiaries of the Medicaid program accounted for approximately 3% of all Koreans, with the remaining population covered by the national health insurance program.[9] Moreover, chronic conditions of diabetes mellitus or hypertension were associated with poor clinical outcomes among those with infectious diseases,[10] while prolonged hospitalizations with greater exposure to causative pathogens may increase the incidence of infectious diseases.[11]

Socioeconomic inequalities continue to widen the gap in health care accessibility among patients with infectious diseases, which may heighten health inequality. Relative to private insurance beneficiaries, Medicaid were estimated to more likely experience death but receive less costly treatments due to their financial burden.[3, 12, 13] Although socioeconomic status could better explain health inequalities in clinical outcomes as well as diverse disease incidence and prognosis, its role in the coronavirus disease 2019 (COVID-19)

pandemic remains unclear, although few evidence have suggested a possible association.[14-17] Thus, further studies are needed to investigate the association between socioeconomic status and novel infectious diseases, as inequalities could be more evident in health outcomes during the COVID-19 pandemic. Therefore, this study was aimed to investigate the association between socioeconomic status, using health insurance type as a proxy, and infection with the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) as well as COVID-19-related clinical outcomes.

MATERIALS AND METHODS

Data Source

We used South Korea's Health Insurance Review and Assessment Service (HIRA) database, which was released by the South Korean government as the world's first de-identified COVID-19 nationwide data, on March 27, 2020 (Supplementary Material 1). South Korea has a universal single-payer healthcare system, provided through the National Health Insurance (NHI), and therefore, it covers its entire population of 50 million. Moreover, South Korea uses a fee-for-service reimbursement system that allows for healthcare utilization by people from all settings, being available for inpatients, outpatients, and nursing homes.

The HIRA database contains healthcare utilization data of all those who received a test for COVID-19 (as of May 15, 2020), which are also linked to their 3-year history (January 1, 2017 to May 15, 2020). The HIRA database anonymized all patient identifiers such that they were de-identifiable, and linked them to their sociodemographic characteristics, healthcare utilization history, diagnosis (International Classification of Diseases 10th Revision [ICD-10] codes), and prescription information. The overall positive predictive value between diagnoses recorded in claims and hospitals' electronic medical records was found to be 82%.[18] Information on whether a patient tested positive for COVID-19 or those who died

were linked from South Korea's Centers for Disease Control & Prevention (KCDC) database.

Study Population

To examine the association between health insurance types and infection with SARS-CoV-2, we identified all adults (aged ≥18 years) who received a diagnostic test for COVID-19 between January 1, 2020 and May 15, 2020 (n=232,390). Among those who obtained positive results from the diagnostic test, we assessed the association between their health insurance type and the risk of COVID-19-related clinical outcomes (Figure 1). Patients were defined as confirmed cases of COVID-19 when results from the reverse transcription polymerase chain reaction tests were positive for SARS-CoV-2 RNA.[19] We classified both of cohorts our study into beneficiaries of NHI or Medicaid programs, with the cohort entry defined as the earliest date among COVID-19-related claims recorded in the HIRA database (Supplementary Material 1).

Outcome Definition

We first estimated the incidence of being tested positive for COVID-19 among those who received a diagnostic test for COVID-19. We then estimated the incidence of COVID-19-related clinical outcomes, which was defined as a composite endpoint of all-cause death, intensive care unit (ICU) admission, and use of mechanical ventilation (primary composite outcome). We defined our secondary outcomes as the individual events of the primary composite outcome (Supplementary Material 2).

Potential Confounders

We identified potential confounders by investigating the association with exposure (health insurance type) and outcome (COVID-19 incidence or its subsequent clinical

outcomes). Age and sex were assessed on cohort entry. Comorbidities (hypertension, hyperlipidemia, diabetes mellitus, asthma, chronic obstructive pulmonary disease, atherosclerosis, heart failure, myocardial infarction, stroke, renal failure, chronic liver disease, fractures, osteoarthritis, rheumatoid arthritis, psychiatric disorders, thyroid disorders, osteoporosis, dementia, malignancy), severe incurable diseases (disease based on Medicaid eligibility criteria, including rare or incurable diseases), and use of co-medications (angiotensin converting enzyme inhibitors, angiotensin-receptor II blockers, β-blockers, calcium channel blockers, diuretics, nitrates, antidiabetic medications including insulin, anxiolytics, antipsychotics, antidepressants, non-steroidal anti-inflammatory drugs [NSAIDs], anticoagulants) were assessed in the year prior to cohort entry (Supplementary Material 2). We also assessed the Charlson comorbidity index, (CCI) score using previously validated algorithms.[20, 21]

Statistical Analysis

We summarized baseline characteristics using counts with proportions for categorical variables or mean with standard deviation (SD) for continuous variables. We used the χ^2 test for categorical variables and the t-test for continuous variables to determine if any statistically significant differences were present between health insurance types.

We estimated the cumulative incidence with 95% confidence intervals (CI) of infection with SARS-CoV-2 and COVID-19 related clinical outcomes for each health insurance type. We then conducted three logistic regression models to estimate odds ratio (OR) with 95% confidence intervals (CIs) for the risk of SARS-CoV-2 infection or the risk of adverse clinical outcomes associated with the health insurance type. The first model was unadjusted for potential confounders. The second model was adjusted for age and sex. The third model, considered our main analysis, was adjusted for age, sex, and the CCI score.

Subgroup and Sensitivity Analyses

We conducted subgroup analyses for both study outcomes of SARS-CoV-2 infection and COVID-19-related clinical outcomes by stratifying on Medicaid type (Type 1 and Type 2), sex, and age group (<60, 60-69, 70-79, ≥80 years). In South Korea, Medicaid beneficiaries, or those who earn ≤40% of the national median household income, are classified into either Type 1 (individuals who are incapable of working) or Type 2 (those who are capable of working).[9]

For the sensitivity analysis, we estimated propensity scores (PS) using multivariable logistic regression analysis to obtain comparability between beneficiaries of NHI or Medicaid programs. The health insurance type was set as the dependent variable and all confounders that had a possible association ($p < 0.2$ upon univariate analysis) with the outcome were included as independent variables;[22] age, sex, and CCI score were always included in the model, regardless of their p-values. Using the estimated PS, we applied inverse probability of treatment (IPT) weights, in this instance, the treatment being the type of health insurance.[23, 24] We then conducted univariable logistic regression analyses to estimate IPT weighted ORs with 95% CIs for the COVID-19 incidence or COVID-19-related clinical outcomes associated with the health insurance type.

All statistical analyses were performed using the SAS statistical program (SAS Institute Inc., US), in which a two-tailed alpha of 0.05 was considered statistically significant.

RESULTS

Of the 232,390 individuals who received a diagnostic test for COVID-19, 218,070 (93.8%) and 14,320 (6.2%) were beneficiaries of NHI and Medicaid, respectively (Figure 1). Compared to NHI, Medicaid beneficiaries were older (mean age 63.8 years [SD 17.7] versus

50.2 [20.0]; p < 0.0001), had a higher male percentage (51.5% versus 47.2%; p < 0.0001), and had higher comorbidity burden (mean CCI score 2.4 [SD 1.6] versus 2.2 [1.7]; p < 0.0001). Medicaid beneficiaries had a higher prevalence of comorbidity history and use of co-medications than NHI beneficiaries (Table 1).

Of the individuals who received COVID-19 tests, 8,515 were confirmed cases of COVID-19, of which, 7,777 (91.3%) were NHI beneficiaries and 738 (8.7%) were Medicaid beneficiaries (Figure 1). Among the COVID-19 cases, Medicaid beneficiaries, as compared with NHI beneficiaries, were also older (mean age 57.5 years [SD 16.8] versus 47.8 [19.1]; p < 0.0001), were represented by a larger number of males (47.2% versus 40.2%; p = 0.0002), and had a higher comorbidity burden (mean CCI score 2.0 [SD 1.1] versus 1.7 [1.0]; p < 0.0001). Except for the use of NSAIDs (71.4% versus 78.4%; p < 0.0001), Medicaid beneficiaries had a comparable or higher prevalence of comorbidity history and use of co-medications than NHI beneficiaries (Table 1).

The cumulative incidence of SARS-CoV-2 infection was 5.15% (738 out of 14,320) and 3.57% (7,777 out of 218,070) for Medicaid and NHI beneficiaries, respectively. Compared to NHI, Medicaid beneficiaries were associated with a 22% increased risk of SARS-CoV-2 infection (age, sex, CCI- adjusted OR 1.22, 95% CI 1.09-1.38); the sensitivity analysis results remained consistent (IPT weighted OR 1.17, 95% CI 1.05-1.30; Table 2). Findings from our subgroup analyses revealed no statistically significant differences between the association of Medicaid beneficiaries with SARS-CoV-2 infection by Medicaid type, sex, and age group (Figure 2).

For the primary composite outcome (all-cause death, ICU admission, mechanical ventilation use), the cumulative incidence was 9.35% (69 out of 738) and 5.18% (403 out of 7,777) for Medicaid and NHI beneficiaries, respectively. Compared to NHI, Medicaid beneficiaries had no association with the primary composite outcome (age, sex, CCI- adjusted

OR 1.10, 95% CI 0.77-1.57). In assessing the individual events of the primary composite outcome, Medicaid beneficiaries, as compared with NHI, did not indicate an increased risk of all-cause death (OR 1.35, 95% CI 0.90-2.02), ICU admission (OR 0.98, 95% CI 0.53-1.79), and mechanical ventilation use (OR 0.77, 95% CI 0.41-1.42), the sensitivity analysis yielding analogous findings (Table 2). Likewise, there was no association between Medicaid beneficiaries and the risk of our primary composite outcome by Medicaid type, sex, and age group (Figure 2).

DISCUSSION

In this nationwide retrospective cohort study of 14,320 patients who received diagnostic tests for COVID-19 in South Korea, Medicaid beneficiaries, as compared with those of NHI, were associated with a 22% increased risk of infection with SARS-CoV-2. On the other hand, Medicaid beneficiaries had non-statistically significant associations with the risk of our primary composite outcome of all-cause death, ICU admission, and mechanical ventilation use, when compared to those of NHI. Thus, our findings suggest that although Medicaid beneficiaries had higher risks of being infected with SARS-CoV-2, the risk of COVID-19-related clinical outcomes was not increased. Findings from this study provide important and novel evidence in that, during times of infectious disease pandemics, disparities in socioeconomic status could further heighten this gap as Medicaid beneficiaries were more susceptible to COVID-19 than NHI beneficiaries.

This study reconfirms the vital role socioeconomic status may have regarding the incidence of novel communicable diseases and their consequences, a contrasting finding to previous studies that mainly focused on non-communicable chronic diseases or communicable non-respiratory diseases.[10, 25-27] Although these studies proposed traditional socioeconomic-related mechanisms such as unsanitary problems or deprived

environments in infectious diseaess,[7, 8] our study raises an alternative possibility in that socioeconomic factors may also serve as determinants or as transmitted mechanisms in infectious diseases. COVID-19 appears to function as a new path to further widen the health disparities stemming from socioeconomic inequalities present in our society. However, regarding the subsequent clinical outcomes, socioeconomic inequalities, proxied by health insurance type, were less likely to affect the gap in health care accessibility in medical institutions, which is an inconsistent result when compared to prior findings.[3, 10-13] Moreover, such estimates were determined by comparing those with the highest income among NHI beneficiaries, a group that is considered to be the most different from those benefitting from Medicaid. Furthermore, the work capability of individuals, or a key component of socioeconomic status, is less likely to impact clinical outcomes of COVID-19 among Medicaid beneficiaries with low socioeconomic status. Nevertheless, in an epidemic crisis with severe propagation power, such as COVID-19, our findings could act as evidence to support the well-operating public health system and medical institutions in South Korea, regardless of patients' socioeconomic background.

Our findings warrant the need to clarify priorities in healthcare policies, although it still remains unclear as to which specific socioeconomic factor mainly impacts the risk of being infected with SARS-CoV-2 among environmental vulnerability to exposure, health behavior patterns, and communication patterns of population groups with low socioeconomic status. Previous studies have reported Medicaid beneficiaries to have higher risks of lower levels of medication adherence and treatment persistence, lower effectiveness of behavioral intervention programs, and to be more vulnerable to environmental conditions.[28]. In support of these findings, Medicaid beneficiaries from our study were older, had a higher prevalence of not only comorbidity history and use of co-medications but also of an increased risk of SARS-CoV-2 infection when compared to those of NHI. Thus, pre-emptive support

should be provided first and foremost to high-risk groups as they are most likely to be impacted during times of economic or epidemic crises by having vulnerable socioeconomic statuses and further, to retard or eliminate the spread of COVID-19.

The strength of this study is that we used a nationwide healthcare database of South Korea, having representativeness of the entire Korean population, that includes information on healthcare utilization of all COVID-19-related claims as of May 15, 2020. Thus, our findings provide real-world evidence that could prove useful in shaping future healthcare policies to narrow the currently prevalent socioeconomic disparities in times of epidemics or pandemics of infectious diseases. In addition, the HIRA database used in this study is the world's first open and de-identified database containing nationwide information of patients with COVID-19. In being open to both domestic and international researchers, our findings are believed to have high reproducibility. With its source population, our data was sufficiently large to assess this socially important issue.

Our study has some limitations. First, outcome misclassification is possible in defining ICU admission or mechanical ventilation use. However, the validity of the national procedure codes used to define these outcomes is believed to be high as these codes are used for reimbursement processes by the South Korean health insurance authority. Meanwhile, misclassification of a positive test result for COVID-19 or all-cause death is likely to be nil in our study as these records were linked to the KCDC's, which have been thoroughly reviewed by numerous clinicians and government officials. Second, we did not have access to data of detailed socioeconomic status, such as income; occupation; lifestyle factors, such as obesity, alcohol consumption, or smoking status; or of all factors that could be associated with worsened clinical outcomes. Last, residual confounding from unmeasured confounders may be present due to inherent limitations of the health insurance claims-related data used in this study. Nevertheless, by using health insurance type, which takes into account an individual's

income level, occupation, and various other factors, as a surrogate measure for the socioeconomic status, we were able to demonstrate well our study objectives of assessing the association between socioeconomic status and infection with SARS-CoV-2 as well as COVID-19-related clinical outcomes.

In conclusion, the findings of this nationwide retrospective cohort study indicate that socioeconomic status, proxied by health insurance type, was associated with an increased risk of infection with SARS-CoV-2. However, we found no association between socioeconomic status and the risk of a composite endpoint of all-cause death, ICU admission, and mechanical ventilation use. In the meantime, with further investigations warranted, pre-emptive support should be provided to high-risk groups, such as Medicaid beneficiaries, to retard or possibly eliminate the spread of COVID-19 during the ongoing pandemic.

DECLARATIONS

Ethical Statement: Our study complies with the Declaration of Helsinki and the study protocol was approved by the Institutional Review Board of Sungkyunkwan University (SKKU 2020-03-012); obtaining informed consent was waived by the board.

Conflicts of Interest: JSL reports receipt of research funding from Columbia University, outside the submitted work. HEJ reports receipt of research funding from the National Research Foundation of South Korea, outside the submitted work. JYS reports receipt of research funding from the Ministry of Food and Drug Safety, Ministry of Health and Welfare, and National Research Foundation of South Korea; grants from pharmaceutical companies including Amgen, Pfizer, Hoffmann-La Roche, Dong-A ST, Yungjin, outside the submitted work. No other disclosures were reported.

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FIGURE LEGENDS

Figure 1. Overall diagram of our nationwide study

Note: COVID-19, coronavirus disease 2019; HIRA, Health Insurance Review and Assessment Service; NHI, National Health Insurance; KCDC, Korea's Centers for Disease Control & Prevention

†Confirmed COVID-19 cases were patients with positive test results obtained from the reverse transcription polymerase chain reaction method targeting the RNA-dependent RNA polymerase, N, and E genes

Figure 2. Forest plot summarizing the risk of being infected with SARS-CoV-2 and the risk of the primary composite outcome associated with health insurance type when stratified for Medicaid type, sex, and age group

Note: COVID-19, coronavirus disease 2019; NA, not applicable; NHI, National Health Insurance, SARS-CoV-2, severe acute respiratory syndrome coronavirus 2

*Primary composite outcome includes all-cause death, intensive care unit admission, mechanical ventilation use

†Adjusted for age, sex, Charlson comorbidity index score in the multivariable logistic regression model

‡Medicaid beneficiaries, or those who earn <40% of the national median household income, are classified into either Type 1 (individuals who are incapable of working) or Type 2 (those who are capable of working) in South Korea

‖ P-for-interaction was not calculated as the subtype of Medicaid was an exposure variable

Table 1. Characteristics of individuals who received COVID-19 diagnostic tests and those who were tested positive, by health insurance type, in South Korea

	Recipients of COVID-19 Diagnostic Test n=232,390 (%)					Confirmed Cases of COVID-19 n=8,515 (%)				
	National Health Insurance n=218,070 (%)		Medicaid n=14,320 (%)		p-value*	National Health Insurance n=7,777 (%)		Medicaid n=738 (%)		p-value*
Age† (years)										
Mean ± standard deviation	50.2 ± 20.0		63.8 ± 17.7		<0.0001	47.8 ± 19.1		57.5 ± 16.8		<0.0001
19-29	41,802	(19.2)	840	(5.9)	<0.0001	2,039	(26.2)	79	(10.7)	<0.0001
30-39	39,995	(18.3)	541	(3.8)		903	(11.6)	17	(2.3)	
40-49	33,040	(15.2)	1,355	(9.5)		1,047	(13.5)	87	(11.8)	
50-59	30,600	(14.0)	2,638	(18.4)		1,536	(19.8)	195	(26.4)	
60-69	26,631	(12.2)	3,156	(22.0)		1,139	(14.6)	195	(26.4)	
70-79	22,949	(10.5)	2,721	(19.0)		650	(8.4)	104	(14.1)	
80-89	19,257	(8.8)	2,389	(16.7)		391	(5.0)	48	(6.5)	
>89	3,796	(1.7)	680	(4.7)		72	(0.9)	13	(1.8)	
Sex†					<0.0001					0.0002
Male	102,964	(47.2)	7,379	(51.5)		3,127	(40.2)	348	(47.2)	
Female	115,106	(52.8)	6,941	(48.5)		4,650	(59.8)	390	(52.8)	
Charlson comorbidity index Score‡										
Mean ± standard deviation	2.2 ± 1.7		2.4 ± 1.6		<0.0001	1.7 ± 1.0		2.0 ± 1.1		<0.0001
1	37,850	(17.4)	3,227	(22.5)	<0.0001	1,229	(15.8)	91	(12.3)	<0.0001
2	29,667	(13.6)	3,305	(23.1)		862	(11.1)	165	(22.4)	
≥3	24,905	(11.4)	3,802	(26.6)		387	(5.0)	65	(8.8)	
Comorbidities‡										
Hypertension	48,930	(22.4)	5,999	(41.9)	<0.0001	1,372	(17.6)	208	(28.2)	<0.0001
Hyperlipidemia	38,384	(17.6)	3,852	(26.9)	<0.0001	1,224	(15.7)	183	(24.8)	<0.0001
Diabetes mellitus	29,495	(13.5)	4,470	(31.2)	<0.0001	777	(10.0)	145	(19.6)	<0.0001
Asthma	15,375	(7.1)	1,761	(12.3)	<0.0001	383	(4.9)	33	(4.5)	0.5852
COPD	37,010	(17.0)	3,694	(25.8)	<0.0001	1,021	(13.1)	84	(11.4)	0.1773
Atherosclerosis	2,161	(1.0)	331	(2.3)	<0.0001	31	(0.4)	11	(1.5)	<0.0001
Heart failure	5,282	(2.4)	942	(6.6)	<0.0001	84	(1.1)	17	(2.3)	0.0033
Stroke	9,384	(4.3)	1,741	(12.2)	<0.0001	198	(2.5)	61	(8.3)	<0.0001
Myocardial infarction	1,565	(0.7)	262	(1.8)	<0.0001	32	(0.4)	6	(0.8)	0.1178
Renal failure	8,091	(3.7)	1,792	(12.5)	<0.0001	56	(0.7)	17	(2.3)	<0.0001
Chronic liver disease	16,894	(7.7)	2,175	(15.2)	<0.0001	457	(5.9)	83	(11.2)	<0.0001

Fracture	14,394	(6.6)	2,080	(14.5)	<0.0001	344	(4.4)	62	(8.4)	<0.0001
Osteoarthritis	33,865	(15.5)	4,131	(28.8)	<0.0001	1,063	(13.7)	159	(21.5)	<0.0001
Rheumatoid arthritis	3,152	(1.4)	315	(2.2)	<0.0001	105	(1.4)	9	(1.2)	0.7679
Psychiatric disorders	33,143	(15.2)	6,133	(42.8)	<0.0001	857	(11.0)	386	(52.3)	<0.0001
Thyroid disorders	11,993	(5.5)	1,067	(7.5)	<0.0001	389	(5.0)	52	(7.0)	0.0166
Osteoporosis	11,052	(5.1)	1,533	(10.7)	<0.0001	413	(5.3)	54	(7.3)	0.0221
Dementia	11,885	(5.5)	2,253	(15.7)	<0.0001	315	(4.1)	77	(10.4)	<0.0001
Cancer	21,039	(9.6)	1,834	(12.8)	<0.0001	253	(3.3)	31	(4.2)	0.1708
Severe incurable disease[‖]	37,628	(17.3)	4,429	(30.9)	<0.0001	495	(6.4)	60	(8.1)	0.0634
Concomitant medications[‡]										
ACE inhibitors	2,427	(1.1)	396	(2.8)	<0.0001	68	(0.9)	12	(1.6)	0.0431
ARBs	40,853	(18.7)	5,341	(37.3)	<0.0001	1,096	(14.1)	172	(23.3)	<0.0001
β-blockers	28,367	(13.0)	4,272	(29.8)	<0.0001	667	(8.6)	171	(23.2)	<0.0001
Calcium channel blockers	40,060	(18.4)	5,652	(39.5)	<0.0001	943	(12.1)	173	(23.4)	<0.0001
Diuretics	14,107	(6.5)	1,734	(12.1)	<0.0001	429	(5.5)	49	(6.6)	0.2052
Nitrates	8,932	(4.1)	1,469	(10.3)	<0.0001	103	(1.3)	20	(2.7)	0.0026
Antidiabetic drugs	28,926	(13.3)	4,401	(30.7)	<0.0001	729	(9.4)	149	(20.2)	<0.0001
Anxiolytics	127,676	(58.5)	12,052	(84.2)	<0.0001	3,186	(41.0)	544	(73.7)	<0.0001
Antipsychotics	16,336	(7.5)	4,494	(31.4)	<0.0001	316	(4.1)	292	(39.6)	<0.0001
Antidepressants	30,304	(13.9)	5,289	(36.9)	<0.0001	721	(9.3)	231	(31.3)	<0.0001
NSAIDs	177,366	(81.3)	11,814	(82.5)	0.0005	6,101	(78.4)	527	(71.4)	<0.0001
Anticoagulants	53,794	(24.7)	7,739	(54.0)	<0.0001	1,149	(14.8)	231	(31.3)	<0.0001

Note: ACE, angiotensin converting enzyme; ARB, angiotensin-receptor II blocker; COPD, chronic obstructive pulmonary disease; NSAID, nonsteroidal anti-inflammatory drug

[*]The $\chi 2$ test for categorical variables and the t-test for continuous variables were used to determine statistically significant differences between health insurance types

[†]Assessed on cohort entry (the date subjects received the test for COVID-19 or date subjects were tested positive for COVID-19)

[‡]Assessed in the year prior to cohort entry

[‖] Severe incurable diseases are Medicaid eligibility criteria that include rare or incurable diseases

Table 2. Risk of SARS-CoV-2 infection among individuals who received a COVID-19 diagnostic test or worsened clinical outcomes among positive cases of COVID-19, by health insurance type

	No. of Subjects	No. of Events	No. of Events per 100 Patients (95% CI)		Odds Ratio (95% CI)							
					Unadjusted Model		Age and Sex-Adjusted Model		IPT[†,‡] Weighted Model		Age, Sex, CCI-Adjusted Model	
Risk of SARS-CoV-2 infection												
NHI	218,070	7,777	3.57	(3.49-3.64)	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Medicaid	14,320	738	5.15	(4.79-5.52)	1.47	(1.36-1.59)	1.54	(1.42-1.67)	1.17	(1.05-1.30)	1.22	(1.09-1.38)
Primary composite outcome												
NHI	7,777	403	5.18	(4.69-5.67)	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Medicaid	738	69	9.35	(7.25-11.45)	1.89	(1.45-2.47)	1.26	(0.95-1.67)	1.20	(0.90-1.60)	1.10	(0.77-1.57)
All-cause death												
NHI	7,777	238	3.06	(2.68-3.44)	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Medicaid	738	51	6.91	(5.08-8.74)	2.35	(1.72-3.21)	1.68	(1.19-2.36)	1.31	(0.95-1.80)	1.35	(0.90-2.02)
Intensive care unit admission												
NHI	7,777	171	2.20	(1.87-2.52)	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Medicaid	738	18	2.44	(1.33-3.55)	1.11	(0.68-1.82)	0.74	(0.45-1.21)	1.35	(0.84-2.16)	0.98	(0.53-1.79)
Mechanical ventilation use												
NHI	7,777	166	2.13	(1.81-2.46)	1.00 (Ref)		1.00 (Ref)		1.00 (Ref)		1.00 (Ref)	
Medicaid	738	22	2.98	(1.75-4.21)	1.41	(0.90-2.21)	0.86	(0.55-1.37)	0.96	(0.58-1.57)	0.77	(0.41-1.42)

Note: CCI, Charlson comorbidity index score; CI, confidence interval; COVID-19, coronavirus disease 2019; IPT, inverse probability of treatment; NHI, national health insurance; SARS-CoV-2, severe acute respiratory syndrome coronavirus 2

[†]IPT weighted multivariable logistic regression model (considered our sensitivity analysis) for the risk of SARS-CoV-2 infection, in which the propensity score used was estimated by including age, sex, Charlson comorbidity index score, hypertension, hyperlipidemia, diabetes mellitus, asthma, chronic obstructive pulmonary disease, atherosclerosis, heart failure, myocardial infarction, stroke, renal failure, chronic liver disease, fractures, osteoarthritis, psychiatric disorders, thyroid disorders, dementia, malignancy, severe incurable diseases, angiotensin converting enzyme inhibitors, angiotensin-receptor II blockers, β-blockers, calcium channel blockers, diuretics, nitrates, antidiabetic medications including insulin, anxiolytics, antipsychotics, antidepressants, non-steroidal anti-inflammatory drugs, anticoagulants in the multivariable logistic regression model (c-statistics 0.719)

[‡]IPT weighted multivariable logistic regression model (considered our sensitivity analysis) for the risk of worsened clinical outcomes, in which the propensity score used was estimated by including age, Charlson comorbidity index score, hypertension, hyperlipidemia, diabetes mellitus, asthma, chronic obstructive pulmonary disease, atherosclerosis, heart failure, myocardial infarction, renal failure, chronic liver disease, fractures, osteoarthritis, psychiatric disorders, osteoporosis, dementia, malignancy, severe incurable diseases, and use of angiotensin converting enzyme inhibitors, angiotensin-receptor II blockers, β-blockers, calcium channel blockers, diuretics, nitrates, antidiabetic medications including insulin, anxiolytics, antipsychotics, antidepressants, anticoagulants in the multivariable logistic regression model (c-statistics 0.779)

Figure1

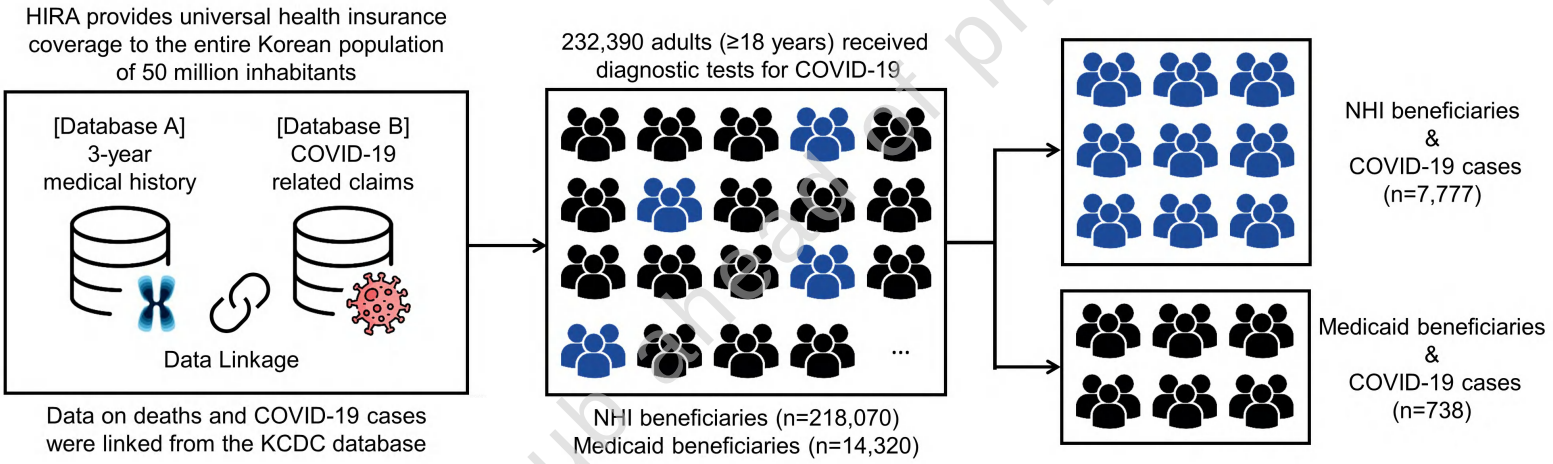

Figure2

	Total No. of Patients	No. of Infected / No. Patients NHI	Medicaid	Adjusted Odds Ratio† (95% confidence interval)	$P_{interaction}$
Risk of being infected with SARS-CoV-2 among individuals who received a COVID-19 test					
Main analysis					
Medicaid versus NHI	232,390	7,777 / 218,070	738 / 14,320	1.22 (1.09-1.38)	NA
Type of Medicaid‡					
Type 1 Medicaid versus NHI	230,632	7,777 / 218,070	572 / 12,562	1.17 (1.03-1.33)	
Type 2 Medicaid versus NHI	219,748	7,777 / 218,070	161 / 1,678	1.72 (1.24-2.38)	
Sex					
Male	110,343	3,127 / 102,964	348 / 7,379	1.34 (1.12-1.60)	0.6071
Female	122,047	4,650 / 115,106	390 / 6,941	1.16 (0.98-1.36)	
Age group (years)					
<60	150,811	5,525 / 145,437	378 / 5,374	1.30 (1.07-1.58)	
60-69	29,787	1,139 / 26,631	195 / 3,156	0.98 (0.76-1.27)	0.6858
70-79	25,670	650 / 22,949	104 / 2,721	1.64 (1.27-2.11)	
≥80	26,122	463 / 23,053	61 / 3,069	1.02 (0.76-1.36)	
Risk of the primary composite outcome* among confirmed cases of COVID-19					
Main analysis					
Medicaid versus NHI	8,515	403 / 7,777	69 / 738	1.10 (0.77-1.57)	NA
Type of Medicaid‡					
Type 1 Medicaid versus NHI	8,349	403 / 7,777	66 / 572	1.12 (0.78-1.61)	
Type 2 Medicaid versus NHI	7,938	403 / 7,777	3 / 161	0.90 (0.21-3.94)	
Sex					
Male	3,475	217 / 3,127	37 / 348	0.95 (0.56-1.62)	0.4904
Female	5,040	186 / 4,650	32 / 390	1.25 (0.76-2.04)	
Age group (years)					
<60	5,903	70 / 5,525	13 / 378	1.21 (0.48-3.09)	
60-69	1,334	87 / 1,139	21 / 195	0.65 (0.27-1.60)	0.6872
70-79	754	99 / 650	16 / 104	1.31 (0.70-2.44)	
≥80	524	147 / 463	19 / 61	1.19 (0.64-2.23)