International Journal of Public Health
ORIGINAL ARTICLE
published: 05 February 2026
doi: 10.3389/ijph.2025.1608533

Association Between Inequality of Emergency Medical Supply Resources and In-Hospital Mortality in Patients With Acute Myocardial Infarction

Young Choi[1], *Seoyoung Park*[1] *and Kyoung Hee Cho*[2]*

[1]*College of Health Sciences, Catholic University of Pusan, Busan, Republic of Korea,* [2]*Department of Healthcare Service Management, College of Health and Medical Sciences, Sangji University, Wonju, Republic of Korea*

Objectives: This study aimed to investigate the relationship between regional inequality in emergency medical supply resources and in-hospital mortality among patients with acute myocardial infarction (AMI) in South Korea.

Methods: We analyzed data from the Korean National Health Insurance Service claims database, focusing on 53,770 AMI patients admitted to emergency departments between 2012 and 2020. The inequality index of emergency medical supply resources was calculated based on the availability of emergency percutaneous coronary interventions (PCI) within each region.

Results: Among 53,770 AMI patients, 4,840 (9.0%) died in-hospital. After adjusting for covariates, patients residing in areas with higher inequality indices had increased risk of in-hospital mortality compared to those in areas with the lowest inequality (index 0.50–0.75: HR 1.504, 95% CI 1.198–1.889; index ≥0.75: HR 1.689, 95% CI 1.493–1.910).

Conclusion: This study highlights the importance of equitable distribution of emergency medical resources to reduce in-hospital mortality among AMI patients. Policymakers should prioritize strategies to address regional disparities in emergency medical supply resources to improve health outcomes.

Keywords: inequality, in-hospital mortality, acute myocardial infarction, disparities, emergency medical supply resources

Edited by:
Paolo Chiodini,
University of Campania Luigi Vanvitelli, Italy

Reviewed by:
Two reviewers who chose to remain anonymous

***Correspondence**
Kyoung Hee Cho,
chokh017@sangji.ac.kr

Received: *21 March 2025*
Revised: *19 August 2025*
Accepted: *03 October 2025*
Published: *05 February 2026*

Citation:
Choi Y, Park S and Cho KH (2026) Association Between Inequality of Emergency Medical Supply Resources and In-Hospital Mortality in Patients With Acute Myocardial Infarction. Int. J. Public Health 70:1608533. doi: 10.3389/ijph.2025.1608533

INTRODUCTION

Acute myocardial infarction (AMI), one of the conditions with a golden hour period [1], is a medical emergency characterized by a sudden blockage of blood flow to a section of the heart muscle, typically caused by a blood clot in the coronary artery [2]. The concept of the "golden hour" refers to the critical period immediately following a traumatic injury or the onset of a medical emergency, during which prompt medical treatment is most likely to prevent death or serious long-term effects [3, 4]. In recent decades, the mortality rate of AMI in South Korea has declined [5]. However, the in-hospital mortality rate for AMI in South Korea is reportedly approximately 5%–10% [6]; heart disease is the second leading cause of death in the country, with a mortality rate higher than that of other diseases [5].

Previous studies have emphasized that emergency resources are crucial for conditions in which treatment during the golden hour reduces mortality. Timely intervention [7] and skilled personnel [8] are the most important factors in treating these diseases, including AMI. Emergency medical services equipped with trained personnel and the necessary equipment can provide immediate care at the scene, stabilize patients, and improve survival rates [9]. In addition, rapid transportation to an appropriate medical facility should ensure that definitive care is initiated as soon as possible, thereby reducing the likelihood of complications [10–12]. Specialists who can provide timely treatment are crucial [13, 14]. Additionally, environmental factors, such as advanced medical equipment [9], effective emergency care systems [15], strategic resource allocation [16], and hospital preparedness to respond to emergency patients are important. From a policy perspective, it is important to note that regional inequality in emergency medical resources affects the mortality rate.

In most previous studies on the relationship between emergency medical supply resources and in-hospital mortality, regional emergency medical supply resources were defined as the number of emergency medicine doctors, specialists in specific fields, or emergency medical institutions in a region [17–21]. However, in cases of absence of emergency medical institution or specific specialists at the time of need and patient transfer to other emergency medical institutions, the number of emergency medical institutions or specialists in the region is only a nominal number and cannot be considered as an actual emergency medical resource.

The aim of this study was to define the inequality in regional emergency medical supply resources available as emergency medical resources when necessary and to identify the relationship between the inequality in regional emergency medical supply resources and in-hospital mortality in AMI.

METHODS

Data Source

This study used data from the Korean National Health Insurance Service (KNHIS) claims database. Korea's health insurance operates as a national health insurance system, and when any citizen uses medical services, medical institutions request that the KNHIS provide medical service usage details to the patient. This study used customized data provided by the KNHIS. Customized health information refers to the data that are processed and provided as customized data so that the health information data collected, held, and managed by the KNHIS can be used for policy and academic research purposes. This study included all patients who received emergency medical services between 2012 and 2020.

Study Population

During 2012–2020, a total of 1,052,397 patients used emergency medical services for AMI. AMI was defined as a case billed with the 10th revision of the International Classification of Diseases (ICD) code I21.x as the main diagnostic code. This study targeted 57,731 of 1,052,397 patients with AMI admitted to the emergency department. Because the accuracy of the diagnosis codes in Korean claims data is approximately 70% [22], several exclusion criteria were used to define patients with true AMI. A total of 2,984 patients who used the emergency room for AMI and the type of medical institution was a hospital or clinic, 16 patients whose residence information was unavailable, and 961 patients whose health insurance premiums information was unavailable were excluded. Finally, 53,770 patients were included in this study (**Figure 1**). As this was a retrospective study using de-identified claims data provided by the KNHIS, the requirement for written informed consent was waived. The study protocol was reviewed and approved by the Institutional Review Board of Sangji University (1040782-210120-HR-01-74).

Dependent Variable

In this study, in-hospital mortality was the dependent variable. We defined mortality to include all causes of death as identified from the death certificate data in the national death registry. For survival analysis, the observation period was defined as the duration of the AMI episode, starting from hospital admission with a primary diagnosis of AMI until discharge or in-hospital death. This definition ensures that the outcome measure captures mortality events directly associated with the patient's hospitalization for AMI.

Inequality Index of Emergency Medical Supply Resources by Region

The assessment of emergency medical supply resources was conducted using the number of emergency PCIs performed, with PCI performance identified as the key factor in reducing deaths in patients with acute myocardial infarction. These regions were divided into 256 administrative regions used in Korea, including cities, counties, and districts. To calculate the imbalance index of emergency medical supply resources by region, first, the number of PCIs performed as an emergency, not the number of planned PCIs, was calculated for each medical institution in each region. Then, the number of PCIs performed as an emergency was calculated by adding them up by region where the medical institution was located. In addition, the number of cases in which patients who visited a medical institution through the emergency room for AMI were transferred to a medical institution in another region and underwent PCI as an emergency was calculated. For example, assuming that a patient resides in Region A, the number of cases in which PCI was performed as an emergency by a medical institution located in Region A and the number of cases in which patients visited a medical institution for acute myocardial infarction but were transferred to a medical institution located in another region and performed as an emergency were calculated. The denominator was the number of cases in which PCI was performed as an emergency by a medical institution in each region plus the number of cases in which PCI was performed as an emergency by a medical institution located in another region; the numerator was the number of cases in which PCI was performed as an emergency by a medical institution located in another region. If a patient was transferred to another medical institution and underwent emergency PCI but the medical

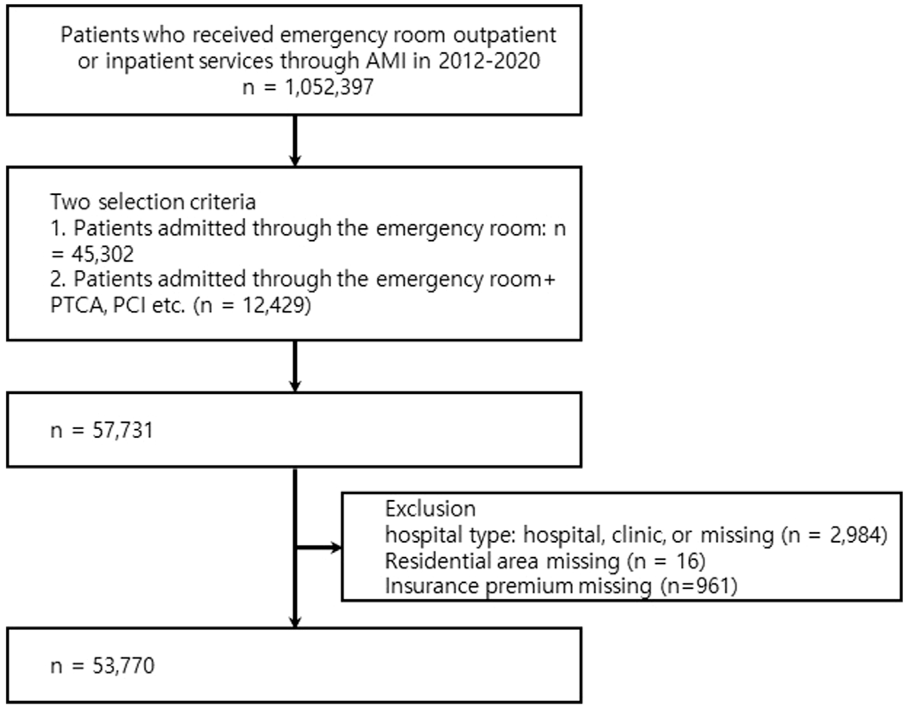

FIGURE 1 | Flow chart of study population selection (Study on the association between inequality of emergency medical supply resources and in-hospital mortality, Republic of Korea, 2021–2024).

institution to which the patient was transferred was in the patient's residential area, it was not included as a case performed in another region. The index value ranges from 0 to 1; the closer it is to 1, the more the number of cases in which PCI was not performed in the patient's residential area, which may be because of lack of medical supply resources for performing PCI in the region. This index was calculated based on patient residence and was divided into four categories as absolute values.

Inequality index of emergency medical supply resources by region

$$= \frac{\begin{array}{c}\text{The number of cases in which PCI}\\ \text{was performed as an emergency in another region}\\ \text{than patient's residence}\end{array}}{\begin{array}{c}\text{The number of cases in which PCI was}\\ \text{performed as an emergency in patient's residence +}\\ \text{The number of cases in which PCI was performed as}\\ \text{an emergency in another region than patient's residence}\end{array}}$$

Covariates

The covariates for our study were age (≤39, 40–49, 50–59, 60–69, or ≥70 years), sex, health insurance premium (medical aid, Q1, Q2, Q3, Q4), residential area (city, county, and borough), whether to transfer (yes or no), Charlson Comorbidity Index [23](CCI) (0, 1, 2, or ≥3), disability (yes or no), whether PCI is performed (yes, or no), and type of medical institution (general or tertiary). The Korean health insurance system is divided into medical aid and health insurance, and in the case of low-income earners below a certain level, they are classified as medical aid and are operated as taxes. In the case of health insurance, premiums are paid based on income. In our study, health insurance premium level was used as a proxy variable for patient income. CCI was used to reflect patient complexity.

Statistical Analysis

Descriptive statistics were calculated for all the variables. The chi-squared test was used to evaluate statistically significant difference in the proportion of categorical variables. The survival probability for all-cause mortality was estimated using the Kaplan–Meier product limit method, and the log-rank test was used to stratify the inequality of the emergency medical supply resource index. To investigate the association between inequality emergency medical supply index and in-hospital mortality, we performed survival analyses using Cox proportional hazards regression. The proportional hazards assumption of the Cox regression models was formally tested using Schoenfeld residuals, and no evidence of violation was observed. All statistical analyses were performed using SAS 9.4 software.

RESULT

Of 53,770 patients who visited the emergency room for AMI, 4,840 (9.0%) died and 48,930 (91.0%) survived (**Table 1**). Significant differences were observed between the two groups in all individual patient characteristics (age, sex, level of health insurance, residential area, CCI, whether transferred, disability, whether

TABLE 1 | Characteristics of the study population, 2012–2020. (Study on the association between inequality of emergency medical supply resources and in-hospital mortality, Republic of Korea, 2021–2024).

Characteristics	Total	Alive		Dead		p-value
	N = 53,770	N = 48,930	(91.0)	N = 4,840	(9.0)	
Age, n (%)						
<39	1,519	1,493	(98.3)	26	(1.7)	<0.0001
40–49	4,654	4,542	(97.6)	112	(2.4)	
50–9	10,102	9,729	(96.3)	373	(3.7)	
60–69	11,748	11,041	(94.0)	707	(6.0)	
>70	25,747	22,125	(85.9)	3,622	(14.1)	
Sex, n (%)						
Male	35,757	33,032	(92.4)	2,725	(7.6)	<0.0001
Female	18,013	15,898	(88.3)	2,115	(11.7)	
Health Insurance Type, n (%)						
Medical aid	5,566	4,910	(88.2)	656	(11.8)	<0.0001
Health Insurance (Q1)	9,557	8,686	(90.9)	871	(9.1)	
Health Insurance (Q2)	8,881	8,175	(92.1)	706	(7.9)	
Health Insurance (Q3)	11,358	10,476	(92.2)	882	(7.8)	
Health Insurance (Q4)	18,408	16,683	(90.6)	1,725	(9.4)	
Patient's residential area, n (%)						
Si (City)	24,109	21,937	(91.0)	2,172	(9.0)	0.0669
GUN (county)	7,525	6,898	(91.7)	627	(8.3)	
GU (borough)	22,136	20,095	(90.8)	2,041	(9.2)	
Transfer						
No	39,571	36,098	(91.2)	3,473	(8.8)	0.0024
Yes	14,199	12,832	(90.4)	1,367	(9.6)	
Charlson's comorbidity index, n (%)						
≤1	1,479	1,394	(94.3)	85	(5.7)	<0.0001
2	25,474	23,414	(91.9)	2,060	(8.1)	
3	18,785	17,125	(91.2)	1,660	(8.8)	
>=4	8,032	6,997	(87.1)	1,035	(12.9)	
Disability, n (%)						
No	40,852	37,605	(92.1)	3,247	(7.9)	<0.0001
Yes	12,918	11,325	(87.7)	1,593	(12.3)	
Performing intervention, n (%)						
No	44,606	40,504	(90.8)	4,102	(9.2)	0.0005
Yes	9,164	8,426	(91.9)	738	(8.1)	
Hospital type, n (%)						
Tertiary hospital	29,058	26,906	(92.6)	2,152	(7.4)	<0.0001
General Hospital	24,712	22,024	(89.1)	2,688	(10.9)	
Inequality Index, n(%)						
<0.25	49,735	45,521	(91.5)	4,214	(8.5)	<0.0001
0.25–0.49	2,125	1,866	(87.8)	259	(12.2)	
0.50–0.74	484	407	(84.1)	77	(15.9)	
≥0.75	1,426	1,136	(79.7)	290	(20.3)	

underwent PCI, and type of hospital). Kaplan–Meier analysis showed that the mean survival time decreased as the inequality in emergency medical supply resource index increased ($p < 0.0001$ by log-rank test; **Figure 2**). The information on residential area, whether transferred, CCI, disability, whether underwent PCI, and hospital type is shown in **Table 1**. **Table 2** presents the in-hospital mortality results of the Cox proportional hazards regression after controlling for all covariates, including age, sex, health insurance premium level, residential area, whether transferred, CCI, disability, whether underwent PCI, and type of hospital. The closer the inequality index of emergency medical resources is to 1, the more likely it is that PCI was performed in the patient's residential area and that patients will be transferred to another area. This index was divided into four categories based on absolute values, and the region corresponding to an inequality index of 0.25 or less, that is, the region with the fewest patient transfers, was used as the reference group. Compared to the reference group, the in-hospital mortality hazard ratio of patients residing in areas with inequality index values of 0.26–0.5 was 1.084 (95% CI, 0.952–1.235), with values of 0.5–0.75 was 1.504 (95% CI, 1.198–1.889), and t with values of 0.75 or higher was 1.689 (95% CI, 1.493–1.910), respectively.

DISCUSSION

In this study, we defined the imbalance in regional emergency medical supply resources available to patients with AMI who visited the emergency room as the extent to which PCI could be performed within the region without transfer to another

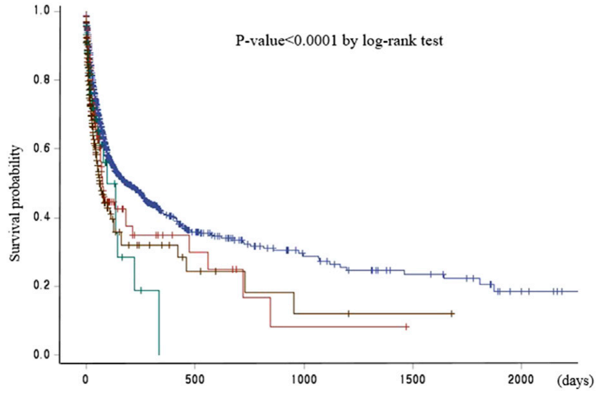

FIGURE 2 | Survival probability by inequality in emergency medical supply resources (Study on the association between inequality of emergency medical supply resources and in-hospital mortality, Republic of Korea, 2021–2024).

TABLE 2 | Hazard ratio for all-cause in-hospital mortality acute myocardial infarction patients admitted through the emergency room during 2012–2020 (Study on the association between inequality of emergency medical supply resources and in-hospital mortality, Republic of Korea, 2021–2024).

Characteristics	Unadjusted		Adjusted	
	HR	95% CI	HR	95% CI
Age				
<39	1.00		1.00	
40–49	1.20	(0.78–1.84)	1.19	(0.77–1.82)
50–9	1.68	(1.13–2.500	1.68	(1.13–2.51)
60–69	2.50	(1.69–3.70)	2.61	(1.77–3.87)
>70	4.86	(3.31–7.15)	5.27	(3.58–7.77)
Sex				
Male	1.00		1.00	
Female	1.27	(1.20–1.35)	0.95	(0.89–1.00)
Health Insurance Type				
Medical aid	1.07	(0.98–1.17)	1.09	(1.00–1.20)
Health Insurance (Q1)	0.98	(0.90–1.06)	1.18	(1.02–1.20)
Health Insurance (Q2)	0.90	(0.83–0.98)	1.09	(1.00–1.19)
Health Insurance (Q3)	0.87	(0.80–0.95)	0.97	(0.90–1.06)
Health Insurance (Q4)	1.00		1.00	
Patient's residential area				
Si (City)	1.13	(1.03–1.23)	1.19	(1.19–1.42)
GUN (county)	1.00		1.00	
GU (borough)	1.12	(1.02–1.22)	0.49	(0.49–0.56)
Transfer				
No	1.00		1.00	
Yes	0.54	(0.51–0.58)	0.52	(0.49–0.56)
Charlson's comorbidity index				
≤1	1.00		1.00	
2	1.25	(1.00–1.55)	1.17	(0.95–1.46)
3	1.18	(0.95–1.46)	1.03	(0.83–1.29)
>=4	1.16	(0.93–1.45)	1.05	(0.84–1.32)
Disability				
No	1.00		1.00	
Yes	1.23	(1.16–1.31)	1.23	(1.15–1.31)
Performing intervention				
No	1.00		1.00	
Yes	0.99	(0.92–1.08)	1.03	(1.04–1.22)
Hospital type				
Tertiary hospital	1.00		1.00	
General Hospital	1.42	(1.34–1.50)	1.29	(1.21–1.37)
Inequality Index				
<0.25	1.00		1.00	
0.25–0.49	1.41	(1.24–1.60)	1.08	(0.95–1.24)
0.50–0.74	1.89	(1.51–2.37)	1.50	(1.20–1.89)
≥0.75	2.14	(1.90–2.41)	1.69	(1.49–1.91)

region when needed. Furthermore, we investigated the relationship between the imbalance in emergency medical supply resources and in-hospital death. The aim of this study was to assess the actual imbalance in regional emergency medical supply resources and clarify the relationship between the actual imbalance and in-hospital death. We found that an increased necessity for patients to be transferred to another region due to the inability to perform PCI locally is associated with a higher risk of in-hospital death for patients living in that region. In addition to the degree of PCI performed in the region, age, sex, patient residence type, whether they were transferred, whether they underwent PCI, and hospital type were associated with the risk of in-hospital death.

AMI is a condition that can be managed effectively during the golden hour. The most important factor in reducing the risk of death for patients is performing PCI, which can open the blocked coronary artery within appropriate time [1, 10]. Most previous studies have simply defined emergency medical resources as the number of specialists, facility equipment personnel, etc., and have revealed their relationship with in-hospital deaths [9, 14, 17]. However, even if there are many specialists in a region who can perform PCI, if they cannot be utilized when PCI is needed, they are only nominal emergency medical resources and not actual emergency medical supply resources. In this study, it was found that the risk of in-hospital death increased in patients living in regions where PCI was not performed and where there was a high degree of transfer to other regions. There are two potential explanations for this finding. First, if the patients' symptom duration and myocardial infarction severity were the same, PCI should have been performed within appropriate time; however, it is possible that they were transferred to other regions and did not receive appropriate intervention within an appropriate time. Second, if PCI was not performed in the region and the patients were transferred to other regions, there is a possibility that the region's PCI performance experience and skill level of PCI performance would be low, which could increase the patient's risk of death. In addition, in areas with insufficient emergency medical supply resources, there is also a possibility of a shortage of resources necessary for patients, such as a lack of resources necessary for transport in addition to emergency medical supply resources, or a lack of facilities, equipment, and personnel that can cover the severity of the patient's condition.

In our study, the risk of in-hospital death was lower in transferred patients, which is inconsistent with the results of previous studies [24–27]. Because our analysis was based on claims data, we were unable to account for various factors such as the timing of the patients' symptom onset, the time from the onset of symptoms to arrival at the medical institution, whether interventions were performed during that period, the number of blocked coronary arteries, the degree of blockage (complete or partial), and other clinical severities related to myocardial infarction. Therefore, we believe that these factors may have influenced our results. Furthermore, according to our findings, transfer reflects the severity of the patient's AMI. If the severity of myocardial infarction was severe upon arrival at the medical institution, there is a possibility that the patient died without the opportunity to transfer. In other words, we believe that this result can be attributed to the less severe nature of AMI in the case of transferred patients, allowing them to be transferred, whereas more severe cases resulted in death. Interestingly, our study found that transferred patients had lower in-hospital mortality compared to those who were not transferred, which appears counterintuitive given that transfer is generally associated with delayed treatment and worse outcomes in AMI. While this finding may reflect selection bias, with more stable patients being transferred and more severe cases dying before transfer, this hypothesis cannot be directly tested with the available claims data. Moreover, due to the expiration of our data access period, we were unable to conduct further subgroup or interaction analyses to explore whether the association between transfer and mortality varies across levels of the inequality index. This limitation highlights the need for future studies with extended data access to investigate this issue in greater depth.

Our study has several limitations. First, our study used claims data, and the accuracy of the primary diagnosis code in the claims data in Korea is 70% [22]. Therefore, it was essential to establish a process to identify "true" AMI cases within the claims dataset. Among a total of 1,052,397 patients with an AMI diagnosis code, we restricted our analysis to those admitted via the emergency department (n = 45,302) and, among them, those who underwent interventional procedures such as PTCA or PCI (n = 12,429). We further excluded cases from clinics (n = 2,984) and patients with missing values in insurance type or residential information (n = 977). Through this process, we derived the final analytic cohort of 53,770 patients. This approach was intended to ensure that our analysis focused on patients with a high likelihood of being true AMI cases, rather than those with suspected AMI who might have been discharged after minimal treatment. However, we acknowledge that this analytic cohort may not fully represent the entire AMI population in South Korea, since some cases (e.g., patients who died upon arrival at the emergency department) may not have been adequately captured. In addition, because our access to the dataset has expired, we were unable to perform further comparative analyses between the analytic cohort and the full AMI population. These limitations should be considered when interpreting our findings, as they may affect the generalizability of the results to all AMI patients. Second, we were unable to consider the various factors that occurred during the prehospital period and their impact on in-hospital death. For example, we were unable to assess the timing of the onset of symptoms, the duration between symptom onset and arrival at the medical institution, or the treatment received during that period. In addition, because we used claims data, we could not determine disease severity in patients with AMI. We could not reflect upon clinically relevant factors, such as the type of AMI, number of occluded coronary arteries, degree of occlusion, and patient's vital signs. Nevertheless, our study has several strengths. First, the analysis used sample data from the patients who visited the emergency room but rather the entire dataset of patients who visited the emergency room for AMI. Therefore, errors caused by sampling could be reduced. Second, the imbalance of regional medical supply resources was assessed based on the actual amount of resources available in an emergency, rather than relying on nominal resources, such as facilities, equipment, and personnel. This is expected to be particularly useful when measuring the supply of resources for conditions, such as AMI that require treatment within the golden hour. Although our study benefited from a large national dataset, the very large sample size may also increase the likelihood that even very small differences or weak associations reach statistical significance. Therefore, our findings should not be interpreted solely based on p-values. Instead, the magnitude of effect sizes and their clinical implications should be given greater weight. In this regard, we emphasize that some associations, while statistically significant, showed relatively small effect sizes, and thus their clinical impact may be limited. This highlights the importance of cautious interpretation when translating statistically significant results into clinical or policy recommendations. Third, although we included several individual-level covariates in the models, the possibility of residual confounding remains. In particular, unmeasured regional characteristics may influence both the inequality index and mortality outcomes, which could bias the observed associations. Moreover, because the exposure was defined at the regional level, the results may be subject to ecological bias and should therefore be interpreted with caution when inferring individual-level risks.

Conclusion

Numerous studies have shown a correlation between medical supply resources and health outcomes, such as patient death or readmission. Most of these previous studies assessed supply resources by quantifying the number of beds per 100 patients, doctors, or nurses. However, for conditions that require treatment within the golden hour, the assessment of available medical resources in emergency situations should include the availability of essential resources for treating the illness, such as specialized medical staff or other necessary hospital resources. This will provide a more precise evaluation of medical resources in emergency situations. This assessment will be useful for estimating the emergency medical supply resources needed by a region or establishing policies for distribution. In addition, to reduce in-hospital deaths of patients with AMI, it is necessary to investigate the factors leading to patient transfer to other regions for PCI and to formulate strategies for the training and deployment of PCI specialists.

ETHICS STATEMENT

As this was a retrospective study using de-identified claims data provided by the KNHIS, the requirement for written informed consent was waived. The study protocol was reviewed and approved by the Institutional Review Board of Sangji University (1040782-210120-HR-01-74).

AUTHOR CONTRIBUTIONS

KC conceptualized and designed the study, acquired the data, interpreted the results, and drafted and revised the manuscript. She also directed the overall research process and secured the research funding. YC and SP performed the data analysis. All authors reviewed the final version of the manuscript and approved it for publication.

FUNDING

The author(s) declare that financial support was received for the research and/or publication of this article. This research was supported by Basic Science Research Program through the National Research Foundation of Korea (NRF) funded by the Ministry of Education (2021R1F1A1060143).

CONFLICT OF INTEREST

The authors declare that they do not have any conflicts of interest.

GENERATIVE AI STATEMENT

The author(s) declare that no Generative AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

REFERENCES

1. Ahmad AZN, Williams B, Smith K, Brennan A, Dinh DT, Liew D, et al. Impact of Emergency Medical Service Delays on Time to Reperfusion and Mortality in STEMI. *Open Heart* (2021) 8(1):e001654. doi:10.1136/openhrt-2021-001654
2. Kristian TJSA, Jaffe AS, Chaitman BR, Bax JJ, Morrow DA, White HD. Executive Group on Behalf of the Joint European Society of Cardiology (ESC)/american College of Cardiology (ACC)/American Heart Association (AHA)/World Heart Federation (WHF) Task Force for the Universal Definition of Myocardial Infarction. *Fourth Universal Definition Myocardial Infarction J Am Coll Cardiol* (2018) 30(72(18)): 2231–64. doi:10.1016/j.gheart.2018.08.004
3. Sean KJCR. Prolonged Field Care: Beyond the Golden Hour. *Wilderness Environ Med* (2017) 28(2(S)):S135–S9. doi:10.1016/j.wem.2017.02.001
4. Stephen GMES, Sarani B. Assessment and Resuscitation in Trauma Management. *Surg Clin North Am* (2017) 97(5):985–98. doi:10.1016/j.suc.2017.06.001
5. Cause of Death. (2017).
6. Kyoung HCCMN, Lee SG, Kim TH, Lee S-H, Park E-C. Measuring of Quality of Care in Patients with Stroke and Acute Myocardial Infarction: An Application of Algebra Effectiveness Model. *Medicine (Baltimore)* (2019) 98(20):e15353. doi:10.1097/MD.0000000000015353
7. Tran LMAE, Haga L, Sridharan N, Chaer RA, Eslami MH. Hospital-Based Delays to Revascularization Increase Risk of Postoperative Mortality and Short Bowel Syndrome in Acute Mesenteric Ischemia. *J Vasc Surg* (2022) 75(4): 1323–33.e3. doi:10.1016/j.jvs.2021.09.033
8. Lin HCCC, Lee HC. Physician Volume, Physician Specialty and in-hospital Mortality for Patients with Acute Myocardial Infarction. *Int J Cardiol* (2009) 15(2):288–90. doi:10.1016/j.ijcard.2007.12.071
9. Bateman RMSM, Jagger JE, Ellis CG, Solé-Violán J, López-Rodríguez M, Herrera-Ramos E, et al. 36th International Symposium on Intensive Care and Emergency Medicine: Brussels, Belgium. 15-18 March 2016. *Crit Care* (2016) 0(Suppl. 2):94. doi:10.1186/s13054-016-1208-6
10. Chowdhury IZAM, Chowdhury MZ, Rahman SM, Ahmed M, Cader FA. Pre Hospital Delay and Its Associated Factors in Acute Myocardial Infarction in a Developing Country. *PLoS One* (2021) 24(11):e0259979. doi:10.1371/journal.pone.0259979
11. Johnston SBR, Ziman M. Paramedics and Pre-hospital Management of Acute Myocardial Infarction: Diagnosis and Reperfusion. *Emerg Med J* (2006) 23(5): 331–4. doi:10.1136/emj.2005.028118
12. Vieira RCPMM, Silva LGSE, Pereira DN, Nascimento BR, Jorge AO, Ribeiro ALP. Assessment of the Impact of the Implementation of a Pre-hospital Ambulance System on Acute Myocardial Infarction Mortality in a Developing Country. *Arq Bras Cardiol* (2022) 23(5):756–63. doi:10.36660/abc.20210953
13. Duband BMP, Marcollet P, Gamet A, Decomis MP, Bar O, Saint Etienne C, et al. Early Survival After Acute Myocardial Infarction With ST-Segment Elevation: What Could Be Improved? Insights From France PCI French Registry. *Medicine (Baltimore)* (2022) 101(35):e30190. doi:10.1097/MD.0000000000030190
14. Di Salvo TTPS, Lloyd-Jones D, Smith AJ, Villarreal-Levy G, Bamezai V, Hussain SI, et al. Care of Acute Myocardial Infarction by Noninvasive and Invasive Cardiologists: Procedure Use, Cost and Outcome. *J Am Coll Cardiol* (1996) 27(2):262–9. doi:10.1016/0735-1097(95)00488-2
15. Balamurugan APM, Selig JP, Felix H, Ryan K. Association Between System Factors and Acute Myocardial Infarction Mortality. *South Med J* (2018) 111(9): 556–64. doi:10.14423/SMJ.0000000000000853
16. Canto JGRW, French WJ, Gore JM, Chandra NC, Barron HV. Payer Status and the Utilization of Hospital Resources in Acute Myocardial Infarction: A Report from the National Registry of Myocardial Infarction 2. *Arch Intern Med* (2000) 27(6):817–23. doi:10.1001/archinte.160.6.817
17. Ansah JPAS, Lee LH, Shen Y, Ong MEH, Matchar DB, Schoenenberger L. Modeling Emergency Department Crowding: Restoring the Balance Between Demand for and Supply of Emergency Medicine. *PLoS One* (2021) 12(1): e0244097. doi:10.1371/journal.pone.0244097
18. Ford JKJ, Brittain J, Bentley C, Sowden S, Castro A, Doran T, et al. Reducing Inequality in Avoidable Emergency Admissions: Case Studies of Local Health Care Systems in England Using a Realist Approach. *J Health Serv Res Policy* (2022) 27(1):31–40. doi:10.1177/13558196211021618
19. Xiong CXY, Chen H, Cheng J. Regional Inequality and Associated Factors of Emergency Medicine Beds Distribution in China. *Int J Public Health* (2024) 8(69):1606812. doi:10.3389/ijph.2024.1606812
20. E B. The Relationship Between Regional Inequalities in the Provision of Emergency Health Services and Other Health Services. *Medicine (Baltimore)* (2023) 10(45):e35930. doi:10.1097/MD.0000000000035930
21. Deák MSCG, Pápai G, Dombrádi V, Nagy A, Nagy C, Juhász A, et al. Investigating the Geographic Disparities of Amenable Mortality and Related Ambulance Services in Hungary. *Int J Environ Res Public Health* (2021) 25(3):1065. doi:10.3390/ijerph18031065

22. Ry K. *Introduction of National Patients Sample Data of Korean Health Insurance Review and Assessment Service* (2011).
23. Charlson MEPP, Ales KL, MacKenzie CR. A New Method of Classifying Prognostic Comorbidity in Longitudinal Studies: Development and Validation. *J Chronic Dis* (1987) 40(5):373–83. doi:10.1016/0021-9681(87)90171-8
24. van Diepen SWP, Lopes RD, White KR, Weaver WD, Van de Werf F, Ardissino D, et al. Transfer Times and Outcomes in Patients with ST-segment-elevation Myocardial Infarction Undergoing Interhospital Transfer for Primary Percutaneous Coronary Intervention: APEX-AMI Insights. *Circ Cardiovasc Qual Outcomes* (2012) 1(4):437–44. doi:10.1161/CIRCOUTCOMES.112.965160
25. Kang MGKY, Kim K, Park HW, Koh JS, Park JR, Hwang SJ, et al. Cardiac Mortality Benefit of Direct Admission to Percutaneous Coronary intervention-capable Hospital in Acute Myocardial Infarction: Community Registry-based Study. *Medicine (Baltimore)* (2021) 12(10):e25058. doi:10.1097/MD.0000000000025058
26. Barbash IJZH, Angus DC, Reis SE, Chang CH, Pike FR, Kahn JM, et al. Differences in Hospital risk-standardized Mortality Rates for Acute Myocardial Infarction when Assessed Using Transferred and Nontransferred Patients. *Med Care* (2017) 55(5):476–82. doi:10.1097/MLR.0000000000000691
27. Garan ARKR, Li B, Sinha S, Kanwar MK, Hernandez-Montfort J, Li S, et al. Outcomes of Patients Transferred to Tertiary Care Centers for Treatment of Cardiogenic Shock: A Cardiogenic Shock Working Group Analysis. *J Card Fail* (2023) 30(4):564–75. doi:10.1016/j.cardfail.2023.09.003