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Original Article

National Trends and Recurrence of Hospitalized Acute Myocardial Infarction in Indonesia, 2019–2024: A Population-Based Claims Analysis

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Abstract

Background: Acute Myocardial Infarction (AMI) and recurrent AMI remain major contributors to cardiovascular morbidity and mortality in Indonesia. However, national data describing trends in hospitalized AMI incidence and recurrent AMI, particularly during the Coronavirus Disease 2019 (COVID-19) pandemic, are limited.

Methods: We conducted a population-based analysis using nationally representative *Badan Penyelenggara Jaminan Sosial Kesehatan* (BPJS Kesehatan, Social Health Insurance Administration Body) claims sample data from 2019 to 2024, excluding 2021 due to incomplete data. Hospitalized AMI incidence and temporal trends were evaluated using a repeated cross-sectional design, whereas recurrent AMI was examined using longitudinal patient-level linkage. AMI episodes were identified using International Classification of Diseases, Tenth Revision (ICD-10) codes (I21–I22). Survey-weighted analyses estimated the incidence of hospitalized AMI, and survey-weighted logistic regression examined factors associated with recurrent AMI.

Results: We identified 9,494 AMI episodes among 7,618 unique patients. Hospitalized AMI incidence per 100,000 insured population declined from 58.1 in 2019 to 49.8 in 2020, followed by a sustained increase, reaching 80.5 in 2024 and exceeding pre-pandemic levels. Overall, 13.5% of patients experienced recurrent AMI. Recurrent AMI was independently associated with heart failure (OR 3.72; 95% CI 2.84–4.88), hypertension (OR 3.00; 95% CI 2.27–3.96), diabetes mellitus (OR 1.61; 95% CI 1.19–2.17), and male sex (OR 1.57; 95% CI 1.20–2.05). Older age (≥65 years) was not independently associated with recurrent AMI.

Conclusions: Hospitalized AMI incidence in Indonesia rebounded from the early COVID-19 decline and reached its highest level observed in 2024. Recurrent AMI clustered around modifiable cardiometabolic conditions, highlighting critical gaps in secondary prevention. Within a universal health coverage system, recurrent AMI may be a measurable, potentially preventable population-level outcome.

Keywords: Acute myocardial infarction, Recurrent AMI, AMI incidence, Universal health coverage, Indonesia.

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Introduction

Acute Myocardial Infarction (AMI) remains a major cause of mortality and long-term disability worldwide, including in Indonesia.[1-2] Beyond first-time events, recurrent AMI is associated with substantially worse outcomes, yet many recurrent AMIs are preventable through effective secondary prevention.[3-4] In Indonesia, ischemic heart disease and other cardiovascular diseases are consistently among the leading causes of death, underscoring the substantial clinical and public health impact of AMI and recurrent AMI.[2]

While high-income countries have achieved sustained declines in AMI incidence through advances in prevention and acute cardiovascular care,[5] many Low- and Middle-Income Countries (LMICs) continue to experience a high disease burden, younger age at onset, and pronounced sociodemographic disparities.[4,6-7] Evidence from LMICs further indicates substantial gaps in long-term secondary prevention, contributing to elevated risks of recurrent and major cardiovascular events.[4] In Indonesia, clinical risk prediction models have demonstrated a very high risk of recurrent cardiovascular events among patients with established coronary heart disease.[8] However, nationally representative data describing recurrent AMI and temporal trends in hospitalized AMI incidence in Indonesia remain limited.

This evidence gap is particularly salient in the post-Coronavirus Disease 2019 (COVID-19) period. International studies reported declines in AMI hospitalizations during the early pandemic, followed by rebounds as healthcare access normalized.[9–11] Emerging evidence suggests increased post-pandemic cardiovascular risk, potentially related to delayed care, disrupted risk-factor management, and cardiovascular consequences of Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) infection.[12-13] However, their impact on population-level AMI patterns in Indonesia remains unclear. In Indonesia, existing evidence is largely derived from single-center studies or regional registries,[14-15] limiting country-level inference during a period of rapid epidemiologic transition and increasing cardiometabolic risk.[2,16]

Heart disease is among the costliest conditions covered by Indonesia's national health insurance system, *Badan Penyelenggara Jaminan Sosial Kesehatan* (BPJS Kesehatan, Social Health Insurance Administration Body).[2,17] BPJS Kesehatan claims data provide a unique opportunity to generate national estimates of the burden of hospitalized AMI and recurrent AMI within a universal health coverage system.

Therefore, this study had two primary objectives. First, we aimed to estimate national trends in hospitalized AMI incidence per 100,000 insured population in Indonesia from 2019 to 2024 (excluding 2021), spanning the pre-, during-, and post–COVID-19 periods. Second, we aimed to identify demographic and clinical factors independently associated with recurrent AMI within this nationally representative claims sample.

Unlike prior Indonesian studies derived from single-center or regional registries, this study used probability-weighted BPJS Kesehatan claims data to generate national estimates of the incidence of hospitalized AMI and recurrent AMI. While claims-based analyses of AMI have been conducted in high-income countries, comparable national-level evidence from Indonesia has not previously been available.

Methods

Study Design and Data Source

We conducted a population-based analysis using nationally representative BPJS Kesehatan claims data from January 2019 to December 2024. The study incorporated two complementary analytic components. First, national AMI incidence and temporal trends were evaluated using a repeated cross-sectional design at the hospitalization episode level. Second, recurrent AMI was examined using a longitudinal patient-level analysis, in which individuals were followed across claims to identify subsequent AMI hospitalizations at least 30 days apart.

BPJS Kesehatan is Indonesia's national health insurance program, capturing claims from public and private healthcare providers nationwide. During the study period, BPJS Kesehatan population coverage increased from approximately 82–83% in 2019–2020 to over 95% by 2023 and 98% by 2024, based on official audited annual reports.[17–20]

This analysis used hospital claims data, in which each claim includes one primary diagnosis and multiple secondary diagnosis fields, linked using a unique claim identifier. Hospital claims were subsequently linked to BPJS Kesehatan membership records using a unique encrypted patient identifier, enabling linkage of episode-level clinical information with patient-level demographic and insurance data.

The BPJS Kesehatan national sample datasets are constructed using stratified random sampling to generate nationally representative, probability-weighted samples of insured individuals.[21] Rather than using the full national claims database, BPJS Kesehatan provides a representative sample in which each sampled record represents a defined number of insured individuals in the national population. Sampling weights, Primary Sampling Units (PSUs), and strata provided by BPJS Kesehatan were applied to account for the complex survey design and obtain national estimates. Data from 2021 were excluded because BPJS Kesehatan claims data for that year were not available in the national sample release with complete calendar-year coverage. A review of the raw datasets indicated that records became available only partway through the year, resulting in a partial annual representation. Because complete annual data are required for valid estimation of national incidence rates, inclusion of partial-year data could bias temporal trend analyses.

Study Population

AMI episodes were defined using a conservative, high-specificity approach based on the International Classification of Diseases, 10th Revision (ICD-10) codes I21–I22 (acute or subsequent myocardial infarction), which demonstrate a high positive predictive value for hospitalized AMI in administrative data.[22-23] Claims coded as follow-up encounters (Z09) and individuals aged <18 years were excluded. Because initial AMI presentation may occur in outpatient or emergency settings before admission, case identification was not restricted to inpatient claims, although most episodes were identified from inpatient encounters.

Hospital encounters occurring within 30 days of a prior AMI event were consolidated across all care settings to define distinct AMI episodes, minimizing the misclassification of staged procedures, early complications, and inter-hospital transfers as recurrent events, consistent with established administrative data approaches.[24-25]

For patient-level analyses, individuals were identified using a unique encrypted patient identifier, with each patient contributing once to baseline and comorbidity analyses. Patient identifiers were used to link AMI episodes across calendar years for the ascertainment of recurrent AMI. Episode-level analyses were used to estimate annual incidence and temporal trends; accordingly, individual patients could contribute more than one AMI episode, such that incidence reflects the burden of hospitalized AMI events rather than the number of affected individuals in a given year.

Variables

Demographics and Socioeconomic Variables

Demographic variables included age (18–39, 40–54, 55–64, ≥65 years) and sex. Socioeconomic status was assessed using BPJS Kesehatan insurance coverage segmentation, distinguishing government-subsidized beneficiaries—*Penerima Bantuan Iuran* (PBI)—from self-enrolled members (PBPU, *Pekerja Bukan Penerima Upah*), formally employed members (PPU, *Pekerja Penerima Upah*), and non-worker participants (*Bukan Pekerja*).[21] PBI status was used as a proxy for lower socioeconomic status, as eligibility is determined through the national Social Welfare Integrated Data System, targeting households classified as poor or vulnerable based on income, assets, and living conditions.[26]

Comorbidities

Comorbidities were identified from ICD-10 codes recorded during AMI episodes, including hypertension (I10), diabetes mellitus (E10–E14), dyslipidemia (E78), heart failure (I50), atrial fibrillation (I48), chronic kidney disease (N18), and stroke (I60–I69).[22] These conditions were selected a priori based on established associations with AMI incidence, prognosis, and recurrent AMI,[4] and their reliable capture in claims data. For patients with multiple AMI episodes, comorbidities were classified at the patient level and defined as present if recorded during any AMI-related hospitalization.

Recurrent AMI

Recurrent AMI was defined as two or more distinct AMI episodes separated by at least 30 days within the observation period (2019–2024, excluding 2021). The index AMI was defined as the first observed AMI episode for each patient within the study period and does not necessarily represent the patient's first-ever AMI. This outcome was assessed at the patient level. Because recurrent AMI required survival beyond the index hospitalization, individuals who died during the index episode could not contribute to recurrent AMI analyses.

Survey Design

The BPJS Kesehatan national samples incorporate a complex survey design including sampling weights, primary sampling units, and strata. Sampling weights were applied so that each observation contributed proportionally to represent the corresponding number of insured individuals at the national level. Survey design variables were implemented using the *svydesign()* function. Weighted annual AMI incidence per 100,000 insured population was calculated using year-specific national BPJS Kesehatan membership counts as denominators, obtained from official BPJS

Kesehatan audited annual reports.[17–20] Incidence estimates represent non–age-standardized rates of hospitalized AMI.

Statistical Analysis

Weighted proportions were estimated for demographic, socioeconomic, and comorbidity variables using patient-level data. Weighted annual AMI incidence rates were calculated per 100,000 insured population using episode-level data. Associations between demographic and clinical factors and recurrent AMI were examined using survey-weighted patient-level logistic regression, adjusting for age group, sex, hypertension, diabetes mellitus, and heart failure. Covariates were selected a priori based on established clinical relevance and adequate prevalence to ensure model stability, and conditions recorded in fewer than 6% of patients were excluded due to sparse data and potential instability of effect estimates. No missing data were identified for age, sex, episode identifiers, insurance coverage segment, care setting, or survey design variables in the analytic dataset.

Variance estimates and 95% confidence intervals were calculated using the Taylor linearization method to account for the complex survey design. All analyses were conducted using R version 4.5.2 with the survey package.[27] Statistical significance was assessed using two-sided design-based Wald tests ($p < 0.05$).

Results

Baseline Demographic and Comorbidity Characteristics

Across 2019–2024 (excluding 2021 due to incomplete data availability), the analytic sample comprised 9,494 unweighted AMI episodes among 7,618 unique patients in the BPJS Kesehatan national sample (Table 1). Men accounted for the majority of AMI episodes throughout the study period (62%–72% annually), although the proportion of female patients increased from 2019 through 2023 before plateauing (Table 1).

Table 1. Survey-weighted baseline characteristics of patients with hospitalized acute myocardial infarction in Indonesia, 2019–2024.

Overall cohort, unweighted (2019-2024)					
Total unique patients, n					7,618
Total AMI episodes, n					9,494
Variable	**Year**				
	2019	2020	2022	2023	2024
Number of AMI episodes, unweighted	1510	1265	1810	2272	2637
Sex					
Male	72.2%	67.2%	67.1%	62.4%	62.5%
Female	27.8%	32.8%	32.9%	37.6%	37.5%
Mean Age ± SD					
Overall	57.2 ± 12.4	57.4 ± 11.3	58.6 ± 11.9	59.6 ± 12.2	57.7 ± 12.0
Male	56.0 ± 12.1	56.4 ± 10.8	58.2 ± 11.6	58.7 ± 11.5	56.7 ± 12.0
Female	60.1 ± 12.7	59.5 ± 12.0	59.3 ± 12.5	61.0 ± 13.2	59.4 ± 11.9
Age group, years					
18–39	6.9%	4.0%	4.5%	5.0%	6.5%
40–54	35.7%	36.5%	32.9%	28.8%	31.2%
55–64	31.7%	33.3%	30.4%	30.6%	34.8%
≥65	25.8%	26.2%	32.3%	35.7%	27.5%
Insurance coverage segment					
PBI (Government-subsidized)	36.6%	31.7%	40.5%	43.5%	50.5%
PBPU (Self-employed)	26.5%	23.3%	22.4%	21.5%	21.9%
PPU (Formal sector worker)	25.5%	29.1%	25.5%	21.0%	17.0%
BP (Non-Worker)	11.5%	15.8%	11.5%	13.9%	10.1%

Notes: Values are survey-weighted percentages or mean ± SD, unless otherwise specified. Unweighted counts are shown for descriptive purposes. PBI = government-subsidized beneficiaries; PBPU = self-employed; PPU = formal sector workers; BP = non-worker participants.

Mean age ranged from 57.2 to 59.6 years, with women consistently presenting at older ages than men across all study years. AMI burden was concentrated among adults aged 40–64 years, who accounted for approximately 60–70% of patients annually, whereas adults aged 18–39 years comprised a small minority (approximately 4%–7%). The proportion of patients aged ≥65 years increased in the immediate post-pandemic period, peaking in 2023 before declining in 2024. Across all years, PBI represented the largest insurance coverage group, increasing from 36.6% in 2019 to 50.5% in 2024.

Overall, women with AMI exhibited a higher prevalence of most cardiometabolic and vascular comorbidities than men, whereas heart failure was more common among men (Table 2). Hypertension and diabetes mellitus were the most prevalent comorbidities among women, affecting 19.1% and 22.3% of patients, respectively, compared with 15.1% and 16.5% among men. In contrast, heart failure was recorded in 23.0% of male patients and 19.4% of female patients. Other comorbidities—including dyslipidemia, atrial fibrillation, chronic kidney disease, and prior stroke—were recorded in fewer than 6% of both sexes.

Table 2. Survey-weighted prevalence of comorbidities among patients with acute myocardial infarction in Indonesia, stratified by sex, 2019–2024.

Comorbidity	Male (%)	Female (%)
Hypertension	15.1 (13.2–17.0)	19.1 (16.1–22.1)
Diabetes mellitus	16.5 (14.4–18.5)	22.3 (18.5–26.2)
Dyslipidemia	3.6 (2.8–4.3)	4.3 (2.4–6.2)
Heart failure	23.0 (20.6–25.5)	19.4 (16.6–22.3)
Atrial fibrillation	3.2 (2.4–4.0)	5.8 (3.9–7.6)
Chronic kidney disease	3.1 (2.3–4.0)	4.0 (1.5–6.4)
Stroke	3.0 (2.2–3.9)	5.4 (3.2–7.7)

Notes: Values represent survey-weighted prevalence estimates (%) with 95% confidence intervals. Comorbidities were identified using ICD-10 diagnosis codes recorded during AMI-related hospitalizations.

National Trends in AMI Incidence

Survey-weighted national hospitalized AMI incidence declined from 58.1 per 100,000 insured population in 2019 to 49.8 per 100,000 in 2020, coinciding with the early COVID–19 pandemic period. Following this decline, incidence increased to 62.2 per 100,000 in 2022, rose further to 75.2 per 100,000 in 2023, and reached the highest observed incidence of 80.5 per 100,000 in 2024, substantially exceeding pre-pandemic levels (Table 3; Figure 1).

Factors Associated with Recurrent AMI

Overall, 13.5% of patients experienced recurrent AMI during the study period, according to survey-weighted estimates. Most patients had a single AMI hospitalization (86.5%), whereas 9.8% experienced two episodes and 3.7% had three or more AMI hospitalizations.

In survey-weighted logistic regression analyses, recurrent AMI was independently associated with cardiometabolic comorbidities and sex (Table 4; Figure 2). Heart failure demonstrated the strongest association with recurrent AMI (OR 3.72; 95% CI 2.84–4.88; $p < 0.001$), followed by hypertension (OR 3.00; 95% CI 2.27–3.96; $p < 0.001$). Diabetes mellitus was also independently associated with recurrent AMI (OR 1.61; 95% CI 1.19–2.17; $p = 0.002$), as was male sex (OR 1.57; 95% CI 1.20–2.05; $p = 0.001$). In contrast, older age (≥65 years) was not independently associated with recurrent AMI (OR 0.90; 95% CI 0.67–1.21; $p = 0.481$).

Table 3. Survey-weighted annual incidence of hospitalized acute myocardial infarction per 100,000 insured population in Indonesia (2019–2024).

Year	Incidence per 100,000 insured population	95% CI
2019	58.1	(52.4–63.7)
2020	49.8	(43.0–56.6)
2022	62.2	(55.9–68.5)
2023	75.2	(68.2–82.2)
2024	80.5	(73.4–87.6)

Notes: Estimates are survey-weighted national incidence rates per 100,000 insured population with 95% confidence intervals. Denominators were derived from annual BPJS Kesehatan insured population counts. Incidence for 2021 was not estimated due to incomplete claims capture.

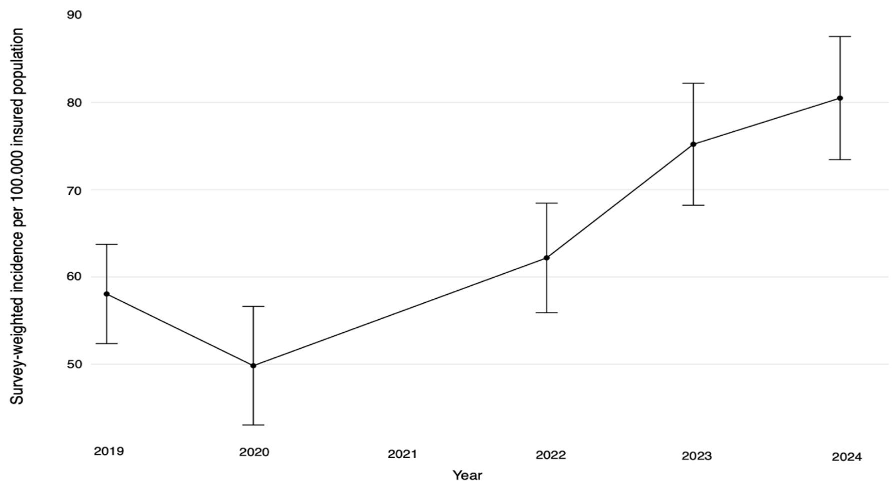

Figure 1. Trends in the incidence of hospitalized acute myocardial infarction per 100,000 insured population in Indonesia, 2019–2024.

Points represent survey-weighted national incidence estimates, and error bars indicate 95% confidence intervals. Denominators were derived from annual BPJS Kesehatan insured population counts. Data for 2021 were unavailable because of incomplete claims capture.

Table 4. Survey-weighted odds ratios for factors associated with recurrent acute myocardial infarction in Indonesia, 2019–2024.

Variable	Odds ratio (OR)	95% Confidence interval	p-value
Age ≥65 years	0.90	0.67 – 1.21	0.481
Male sex	1.57	1.20 – 2.05	0.001
Diabetes mellitus	1.61	1.19 – 2.17	0.002
Hypertension	3.00	2.27 – 3.96	<0.001
Heart failure	3.72	2.84 – 4.88	<0.001

Notes: Odds ratios (ORs) and 95% confidence intervals were derived from survey-weighted logistic regression adjusted for age group, sex, hypertension, diabetes mellitus, and heart failure. OR >1 indicates increased odds of recurrent AMI.

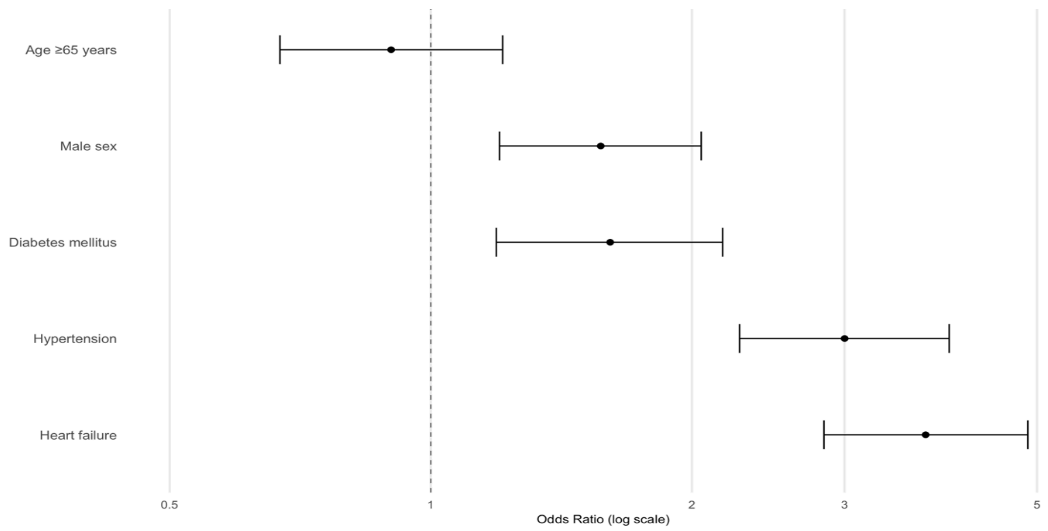

Figure 2. Survey-weighted odds ratios for factors associated with recurrent acute myocardial infarction in Indonesia, 2019–2024.

Forest plot showing adjusted odds ratios (ORs) and 95% confidence intervals from the survey-weighted logistic regression model. The vertical dashed line indicates the null value (OR = 1).

Discussion

Using nationally representative claims data, this study provides the first national assessment of hospitalized AMI incidence and recurrent AMI in Indonesia and offers insight into post-pandemic cardiovascular burden within the national health system. We observed a decline in hospitalized AMI incidence during the early COVID-19 pandemic, followed by a sustained rebound beginning in 2022 and persisting through 2024, with incidence exceeding pre-pandemic levels. Recurrent AMI was independently associated with hypertension, heart failure, diabetes mellitus, and male sex, defining a clear clinical risk profile within Indonesia's health system. Together, these findings indicate persistently elevated hospitalized AMI incidence in the post–COVID-19 period and underscore the need to strengthen continuity of care beyond the acute episode.

Trends in national AMI incidence, 2019–2024

National AMI incidence declined in 2020 and rebounded beginning in 2022, remaining elevated through 2024. The early pandemic decline is consistent with international reports attributing reductions in AMI hospitalizations to disruptions in healthcare access and care-seeking behavior rather than true reductions in disease occurrence.[9–11] Importantly, incidence exceeded pre-pandemic levels by 2023–2024, suggesting a sustained increase rather than a transient recovery of service utilization.

Beyond normalization of healthcare access, the persistent post-pandemic rise in AMI incidence may reflect delayed expression of cardiovascular risk accumulated during the pandemic, including disrupted chronic disease management, reduced access to preventive services, and adverse lifestyle changes.[12] Emerging evidence also suggests that SARS-CoV-2 infection has been associated with increased medium-term cardiovascular risk through inflammatory and thrombotic mechanisms.[13] Because individual COVID-19 status and behavioral risk factors were not available, these explanations should be considered hypotheses informed by existing literature rather than direct causal inferences. The sustained elevation of hospitalized AMI incidence above pre-pandemic levels from 2022 through 2024, therefore, represents a descriptive signal of post-pandemic cardiovascular burden.

AMI incidence estimates in this study were lower than those reported in other countries, likely reflecting methodological heterogeneity and contextual factors rather than true population-level risk.[28] Accordingly, cross-country comparisons should be interpreted cautiously, as differences in case definitions, age standardization, healthcare-seeking behavior, and event ascertainment vary widely across settings. Nevertheless, the use of consistent case definitions, denominators, and analytic methods across study years supports the interpretability of observed temporal trends within the Indonesian health system.

Sociodemographic patterns in AMI burden

AMI burden in Indonesia was concentrated among working-age adults, with most events occurring between ages 40 and 64. The mean age of AMI patients in this study remained younger than that reported in high-income countries, but comparable to other LMIC and Asian populations, underscoring the concentration of AMI during economically productive years. Men accounted for the majority of AMI episodes and presented at younger ages, whereas women consistently experienced AMI later in life, a pattern widely reported in international AMI studies.[7] AMI burden also disproportionately affected socioeconomically disadvantaged populations, as reflected by the high and increasing proportion of cases among government-subsidized beneficiaries. This pattern aligns with evidence from multinational LMIC studies showing higher cardiovascular event rates and mortality among socioeconomically disadvantaged populations, driven largely by poorer access to effective healthcare and lower uptake of preventive pharmacologic therapies rather than differences in baseline risk profiles.[4,6] Within a universal health coverage system, this concentration of AMI among working-age and disadvantaged groups underscores the relevance of AMI as both a clinical and health system equity concern.

Recurrent AMI and implications for secondary prevention

Recurrent AMI was independently associated with hypertension, heart failure, diabetes mellitus, and male sex, identifying high-risk patient subgroups and underscoring the role of modifiable cardiometabolic factors. Hypertension and heart failure conferred approximately threefold higher odds of recurrent AMI, whereas diabetes mellitus was associated with a substantial increase in recurrent AMI. However, these findings should be interpreted as observational associations rather than evidence of causality. These results emphasize the importance of strengthening secondary prevention strategies focused on blood pressure control, glycemic management, and optimization of heart failure care.

Despite the well-established benefits of secondary prevention following AMI, evidence from LMICs indicates persistent gaps in medication adherence, continuity of care, and access to long-term cardiovascular follow-up.[4,6] In this context, recurrent AMI may reflect missed opportunities to sustain risk-factor control after hospitalization rather than inevitable disease progression. The PURE study supports this interpretation, demonstrating lower rates of recurrent cardiovascular events and mortality in high-income countries despite a higher prevalence of cardiovascular risk factors, largely attributable to more consistent use of evidence-based pharmacologic therapies.[4] In contrast, lower uptake of these therapies and poorer risk-factor control in LMICs may contribute to higher rates of recurrent AMI.[6]

Within Indonesia's universal health coverage system, recurrent AMI is a measurable, potentially preventable outcome that may serve as an indicator of post-AMI care quality. The clustering of recurrent AMI around modifiable cardiometabolic conditions highlights the importance of strengthening continuity of care between acute hospitalization and long-term follow-up. The absence of an independent association with older age should be interpreted with caution, as competing mortality risks and survivor bias may limit the detection of recurrent AMI in administrative data.[29] Taken together, these findings position recurrent AMI as a meaningful signal of secondary prevention performance at the population level.

Strengths and limitations

Key strengths include the use of nationally representative BPJS Kesehatan claims data with survey weights, enabling national estimation of hospitalized AMI incidence and recurrent AMI across Indonesia—analyses not achievable using single-center or regional data. The multi-year design spanning the pre- and post–COVID-19 pandemic facilitated a robust assessment of temporal trends, while the longitudinal linkage enabled identification of recurrent AMI events at the patient level.

Several limitations warrant consideration. First, this study was based on administrative claims data, which are collected primarily for healthcare reimbursement rather than research purposes and may therefore be subject to coding inaccuracies and underreporting of comorbid conditions.[27,30] In addition, administrative claims data do not routinely capture detailed clinical or behavioral information, including cardiac biomarkers, electrocardiographic findings, left ventricular ejection fraction, smoking status, diet, and physical activity. These factors are established determinants of cardiovascular outcomes and risk. Regression models were therefore designed primarily to evaluate clinical and demographic predictors of recurrent AMI, and residual confounding from unmeasured factors may remain.[6-7]

Second, incidence estimates represent crude hospitalized AMI incidence per 100,000 insured population because age-standardized rates could not be calculated due to the unavailability of age-specific BPJS Kesehatan membership denominators. Reported trends, therefore, reflect changes in hospitalized AMI burden rather than age-adjusted population risk, and shifts in the age structure of BPJS Kesehatan membership over time may influence interpretation of temporal patterns.

Third, recurrent AMI was assessed within a fixed observation window (2019–2024), with 2021 excluded due to incomplete data availability. Events occurring outside this period, including those before 2019, during the excluded year, or after the observation period, could not be captured. Consequently, the first observed AMI episode may not represent a true first-ever AMI. The exclusion of 2021 also limits direct observation of the trajectory between the initial pandemic-related decline in AMI hospitalizations and the subsequent rebound, and the magnitude of the post-pandemic increase may be sensitive to unobserved trends during this interval.

Fourth, although BPJS Kesehatan coverage is near universal at the national level, the study population consisted of BPJS-insured individuals and may not fully represent uninsured individuals or those receiving care exclusively through private healthcare systems.

Finally, competing mortality risks and survivor bias, particularly among older patients, may attenuate observed associations.[29] Additionally, prehospital and fatal AMI events occurring before hospital admission could not be captured, and the overall population burden of AMI is therefore likely higher.

These limitations are inherent in administrative data and are unlikely to vary systematically across study years, supporting the internal validity of the observed temporal trends. Accordingly, these findings are highly relevant to Indonesia and informative for other settings with near-universal health insurance and similar claims-based data systems.

Conclusion

This nationally representative analysis shows that hospitalized AMI incidence in Indonesia declined during the early COVID-19 pandemic but rebounded and remained elevated through 2024, disproportionately affecting working-age and socioeconomically disadvantaged populations. Recurrent AMI clustered around modifiable cardiometabolic conditions—hypertension, heart failure, and diabetes mellitus—identifying key targets for secondary prevention. Recurrent AMI may serve as a pragmatic population-level indicator of secondary prevention performance within Indonesia's universal health coverage system. Together, these findings support efforts to strengthen continuity of care beyond the acute episode, particularly in the context of the rising incidence of hospitalized AMI in the post-pandemic period.

List of Abbreviations

AMI	Acute Myocardial Infarction
BPJS Kesehatan	Social Health Insurance Administration Body
COVID-19	Coronavirus Disease 2019
ICD-10	International Classification of Diseases, Tenth Revision
LMICs	Low- and Middle-Income Countries
PBI	Government-subsidized Beneficiaries
PBPU	Self-enrolled Members
PPU	Formally Employed Members
SARS-CoV-2	Severe Acute Respiratory Syndrome Coronavirus 2

Ethical Clearance

This study was approved by the Medical and Health Research Ethics Committee (MHREC), Faculty of Medicine, Public Health and Nursing, Universitas Gadjah Mada–Dr. Sardjito General Hospital, Yogyakarta, Indonesia (Reference No. KE/FK/0298/EC/2026).

Publication Approval

All authors consent to the publication of this manuscript.

Authors' Contributions

GY conceived and designed the study, performed data extraction, data management, statistical analyses, interpreted the results, drafted the manuscript, and critically revised the manuscript for important intellectual content. AD contributed to the study conception and design, supervised the research, interpreted the findings, critically revised the manuscript for important intellectual content, and approved the final version for publication. Both authors read and approved the final version of the manuscript.

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Conflict of Interest

None.

Availability of Data and Materials

Not applicable.

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Copyright/Permissions for Figures

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Authors acknowledge that artificial intelligence (AI) tools were only used to assist in language editing and did not generate or alter the scientific content, analyses, or conclusions presented in this manuscript.

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