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Review Article

The Risk Factors and Hospital Mortality of Percutaneous Coronary Intervention Patients in Prepandemic and During Pandemic COVID-19: A Systematic Review

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ABSTRACT

Background: The COVID-19 pandemic is a global health issue that impact healthcare systems. COVID-19 infections affect the risk factors and mortality in patients undergoing PCI. The aim of this study is to determine the differences in risk factors and mortality rates of patients undergoing PCI before and during the COVID-19 pandemic. **Method**: We performed a systematic search on risk factors and hospital mortality of PCI patients in pre-pandemic and during pandemic COVID-19. Study reporting patient after year 2022 are excluded. The article published between 2019 to 2022. The literature selection was conducted following the PRISMA algorithm. **Result:** Eight journals were utilized, ensuring their relevance, compatibility, and adherence to the inclusion and exclusion criteria. In this study, it is explained that there has been a decrease in the number of patients undergoing PCI procedures during the COVID-19 pandemic. The increase of risk factor and there is no significant different hospital mortality of PCI patients before and during pandemic.

Highlights:

1. COVID-19 pandemic remains one of the interesting subject to discuss due to its large scale impact.
2. PCI is one of the popularly known method to screen COVID-19, however, depending on the prior screening, this may or may not be conducted. Thus, its frequency is reviewed in this study.

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Introduction

The COVID-19 pandemic has posed unprecedented challenges to healthcare systems worldwide, affecting various aspects of medical care. Among the vulnerable populations, individuals undergoing Percutaneous Coronary Intervention (PCI) face a unique set of circumstances. PCI, a crucial procedure in managing coronary artery disease, has been significantly impacted by the confluence of COVID-19 and cardiovascular health. [1][3][4]

Percutaneous coronary intervention (PCI) is a non-surgical invasive procedure involving a revascularization method used to open coronary arteries that suffer from restricted blood flow to the heart. The COVID-19 pandemic is a health crisis that also affects the risk factors, mortality, and morbidity of patients undergoing PCI procedures worldwide. Understanding the impact of COVID-19 on PCI procedures is crucial for determining accurate triage and timely interventions. The COVID-19 pandemic has significantly influenced the interaction within cardiovascular patient healthcare services. [1][2][9]

The relationship between COVID-19 and PCI outcomes extends beyond the procedural realm. Patients undergoing PCI often exhibit comorbidities such as hypertension, diabetes, and obesity factors that have been highlighted as potential risk amplifiers for severe COVID-19 complications [6][11]. Moreover, the pandemic-induced alterations in healthcare delivery, resource allocation, and patient management strategies have undeniably influenced the clinical course and mortality rates among PCI recipients. This intersection demands a meticulous investigation into the intricate connections between COVID-19, pre-existing risk factors, and the subsequent impact on the mortality rates of these patients. [4][5] Thus, this study endeavors to explore and dissect the multifaceted dimensions of how COVID-19 influences the risk profiles and mortality rates among individuals undergoing PCI, shedding light on critical aspects that shape their clinical trajectories.[8][10][12]

Methods

The present preview followed the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020. No ethical approval was required as no patients directly participated in this study.

Eligibility

We performed a systematic search on risk factors and hospital mortality of PCI patients in prepandemic and during pandemic COVID-19. Study published after 2022 are excluded. The article published between 2019 - 2022. The studies written in languanges other than English or Indonesian, and those with no available full text were excluded.

Search Strategy and Selection of Studies

We conducted a comprehensive systematic database search on November 2023 in Pubmed, ScienceDirect, and Scopus. The keyword that will be used are derived from “Risk Factor” AND “Hospital Mortality” AND “Prepandemic” OR “During Pandemic” along with their related MeSH terms, synonyms, and elaboration. Review articles will be excluded but their references will be screened for potentially relevant studies.

Article Extraction

We systematically collected pertinent articles from the studies we included, utilizing a structured and uniform method. We gathered details encompassing general information, research specifics, characteristics of intervention subjects, and their outcomes. Any differences found will be resolved through agreement among all the authors participating in the data extraction.

Quality Assessment

At least two authors will independently carry out the evaluation of bias risk.The Mixed Methods Appraisal Tool (MMAT) 2018 version will be employed as the assessment instrument.

Data Analysis

This study employed a systematic review approach for data analysis. The analysis will be showcased through a narrative summary of the presented studies, examining relationships between them and evaluating their strength. Each study's findings will be narratively presented, contributing to a comprehensive discussion.

Result

The search yielded 369 records, with 34 duplicates identified. Following the screening of titles and abstracts, 306 articles were eliminated. Ultimately, this systematic review encompassed 8 published articles subsequent to a thorough full-text assessment. The PRISMA flow diagram (Fig. 1) visually depicts the study selection process and outlines the grounds for exclusion.

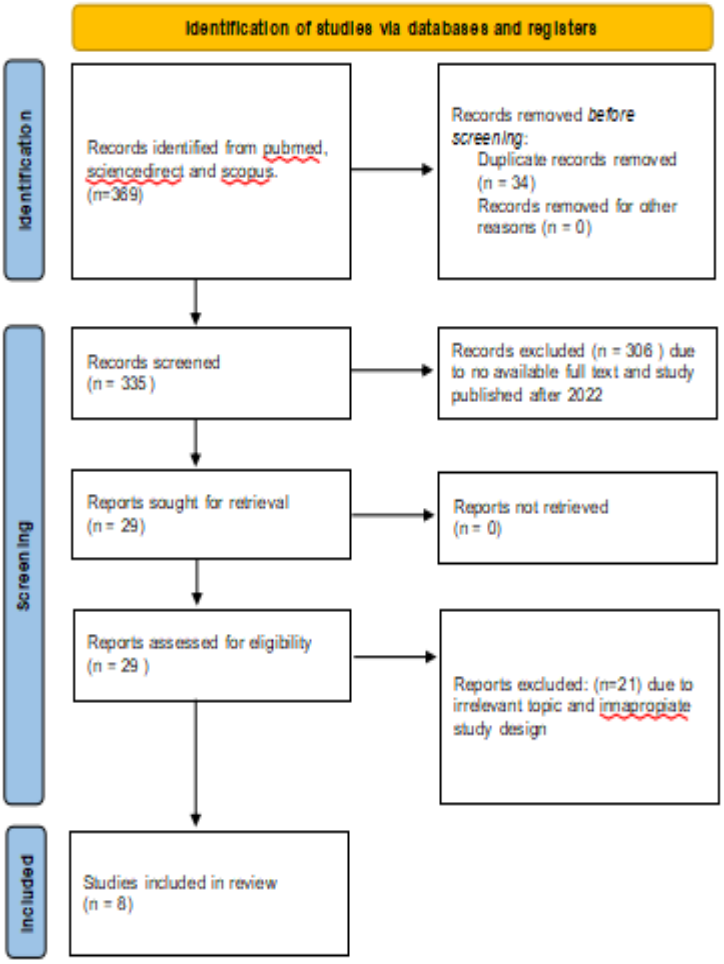

Figure 1. PRISMA flow of study selection

The Mixed Methods Appraisal Tool (MMAT) 2018 version was utilized to evaluate all the case reports included. The condensed checklist for critical appraisal indicates that overall, the articles exhibit low risks.

The Risk Factor and Hospital Mortality of PCI Patients

Eight studies have reported the decreased rate of the PCI patients in pandemic COVID-19. Several studies (Azzalini L et al., 2022; Yamaji K et al., 2022; Kwok CS et al., 2020; Ramzy J et al., 2022) indicated that the reduction in the number of risk factors among patients undergoing PCI during the COVID-19 pandemic has led to a decrease in hospital mortality rates.

Table 1. The risk factor of included systematic reviews

Author	Study Design	Sample Size	Risk Factors							
			Diabetes Mellitus	Myocardial Infarcion	Hypertension	Cerebrovascular Disease	Chronic Lung Disease	Smoker	Peripheral Arterial Disease	Chronic Heart Failure
Azzalini L et al. (2022)	Retrospective Study	Pre-Pandemic: 25,737 Patients, Pandemic: 21,822 Patients	Pre-Pandemic: 10,587 Patients (41.1%), Pandemic: 8,969 Patients (41.1%), p: 0.009	Pre-Pandemic: 8,329 Patients (32.4%), Pandemic: 7030 Patients (32.2%), p: 0.750	Pre-Pandemic: 22,229 Patients (86.4%), Pandemic: 18,869 Patients (86.5%), p: 0.939	Pre-Pandemic: 4,155 Patients (16.1%), Pandemic: 3,584 Patients (16.4%), p: 0.414	Pre-Pandemic: 5,011 Patients (19.5%), Pandemic: 4,249 Patients (19.5%), p: 0.717	Pre-Pandemic: 6,036 Patients (23.5%), Pandemic: 5,099 Patients (23.4%), p: 0.833	Pre-Pandemic: 3,623 Patients (14.1%), Pandemic: 3,004 Patients (13.8%), p: 0.338	Pre-Pandemic: 7,978 Patients (31.0%), Pandemic: 6,759 Patients (31.0%), p: 0.947
Yamaji K et al. (2022).	Cross-sectional Restrospective Study	Pre-Pandemic: 236,807 Patients, Pandemic: 252,194 Patients	Pre-Pandemic: 107,180 Patients (45.2%), Pandemic: 112,240 Patients (44.5%), p: <0.001	Pre-Pandemic: 53,067 Patients (22.4%), Pandemic: 55,322 Patients (22.4%), p: <0.001	Pre-Pandemic: 179,265 Patients (75.7%), Pandemic: 189,538 Patients (75.2%), p: <0.001	NA	Pre-Pandemic: 7,272 Patients (3.07%), Pandemic: 6,630 Patients (2.63%), p: <0.001	Pre-Pandemic: 71,749 Patients (30.2%), Pandemic: 75,744 Patients (30.0%), p: 0.04	Pre-Pandemic: 19,320 Patients (8.15%), Pandemic: 19,632 Patients (7.78%), p: <0.001	Pre-Pandemic: 37,340 Patients (15.7%), Pandemic: 37,424 Patients (15.2%), p: 0.009
Kwok CS et al. (2020)	Retrospective Cohort Study	Pre-Pandemic: 33,255 Patients, Pandemic:	Pre-Pandemic: 6,006 Patients (18.5%),	Pre-Pandemic: 4,046 Patients (12.4%),	Pre-Pandemic: 13,846 Patients (43.2%),	Pre-Pandemic: 1,220 Patients (3.8%),	NA	Pre-Pandemic: 7,869 Patients (40.9%),	Pre-Pandemic: 898 Patients (2.8%),	NA

		683 Patients	Pandemic: 107 Patients (16.4%), p: 0.16	Pandemic: 72 Patients (11.4%), p: 0.43	Pandemic: 234 Patients (39.4%), p: 0.067	Pandemic: 16 Patients (2.7%), p: 0.16		Pandemic: 148 Patients (38.1%), p: 0.26	Pandemic: 10 Patients (1.7%), p: 0.10	
Ramzy J et al. (2022).	Cohort Study	Pre-Pandemic: 839 Patients, Pandemic: 145 Patients	Pre-Pandemic: 230 Patients (27.4%), Pandemic: 38 Patients (26.2%), p: 0.76	Pre-Pandemic: 458 Patients (54.6%), Pandemic: 88 Patients (60.7%), p: 0.17	NA	Pre-Pandemic: 26 Patients (3.1%), Pandemic: 3 Patients (2.1%), p: 0.50	NA	NA	Pre-Pandemic: 28 Patients (3.3%), Pandemic: 8 Patients (5.5%), p: 0.20	NA
Hannan et al. (2021)	Retrospective	Pre-Pandemic: 3,411 Patients, Pandemic: 187 Patients	Pre-Pandemic: 8.33%, Pandemic: 26.2%, p: 0.65	NA	NA	Pre-Pandemic: 5.25%, Pandemic: 2.14%, p: 0.06	Pre-Pandemic: Severe: 0.03%, Moderate: 0.56%, Mild: 2.52%, Pandemic: Severe: 0.53%, Moderate: 0.53%, Mild: 2.14% p: 0.17	NA	Pre-Pandemic: 3.84%, Pandemic: 1.60%, p: 0.12	Pre-Pandemic: 7.77%, Pandemic: 7.49%, p: 0.70
Mohammad MA et al. (2020)	Observational Study	Pre-Pandemic: 15,213 Patients, Pandemic:	Pre-Pandemic: 3,277 Patients (21.5%),	Pre-Pandemic: 3,322 Patients (21.8%),	Pre-Pandemic: 8,967 Patients (58.9%),	NA	NA	Pre-Pandemic: 2,928 Patients (19.3%),	NA	NA

		2,433 Patients	Pandemic: 527 Patients (21.6%), p: 0.09	Pandemic: 479 Patients (19.6%), p:<0.001	Pandemic: 1,462 Patients (59.8%), p:0.04			Pandemic: 448 Patients (18.3%), p:0.57		
Cinier G et al. (2020)	Retrospective Study	Pre-Pandemic: 174 Patients, Pandemic: 90 Patients	Pre-Pandemic: 60 Patients (34.5%), Pandemic: 24 Patients (26.7%), p: 0.196	Pre-Pandemic: 57 Patients (32.8%), Pandemic: 21 Patients (23.3%), p: 0.112	Pre-Pandemic: 88 Patients (50.6%), Pandemic: 41 Patients (45.6%), p: 0.439	Pre-Pandemic: 4 Patients (2.3%), Pandemic: 5 Patients (5.6%), p: 0.281	NA	Pre-Pandemic: 117 Patients (67.2%), Pandemic: 43 Patients (47.8%), p: 0.002	NA	NA
Gong X et al.(2022).	Retrospective Cohort Study	Pre-Pandemic: 136 Patients, Pandemic: 110 Patients	Pre-Pandemic: 29 Patients (21.3%), Pandemic: 39 Patients (35.5%), p: 0.014	Pre-Pandemic: 22 Patients (16.2%), Pandemic: 13 Patients (11.8%), p: 0.331	Pre-Pandemic: 78 Patients (57.4%), Pandemic: 67 Patients (60.9%), p: 0.573	Pre-Pandemic: 15 Patients (11%), Pandemic: 15 Patients (13.6%), p: 0.534	NA	Pre-Pandemic: 15 Patients (11%), Pandemic: 15 Patients (13.6%), p: 0.534	NA	NA

Table 2. The mortality of the included systematic reviews

Author	in-Hospital Mortality					
	Death	Myocardial Infarction	Bleeding	Cardiogenic Shock	MACE	Stroke
Azzalini L et al. (2020)	Pre-Pandemic: 435 Patients (1.7%), Pandemic: 444 Patients (2.0%), p: 0.006	Pre-Pandemic: 151 Patients (0.6%), Pandemic: 95 Patients (0.4%), p: 0.025	Pre-Pandemic: 255 Patients (1.0%), Pandemic: 206 Patients (0.9%), p: 0.637	Pre-Pandemic: 432 Patients (1.7%), Pandemic: 372 Patients (1.7%), p: 0.869	NA	Pre-Pandemic: 104 Patients (0.4%), Pandemic: 105 Patients (0.5%), p: 0.231`
Yamaji K et al. (2022)	Pre-Pandemic: 4364 Patients (1.73%), Pandemic: 4588 Patients (1.94%), p: 0.001	Pre-Pandemic: 1341 Patients (0.532%), Pandemic: 1375 Patients (0.581%), p: 0.02	Pre-Pandemic: 891 Patients (0.353%), Pandemic: 935 Patients (0.395%), p: 0.02	Pre-Pandemic: 2166 Patients (0.859%), Pandemic: 2287 Patients (0.966%), p: 0.001	NA	NA
Kwok CS et al. (2022).	Pre-Pandemic: 4364 Patients (1.73%), Pandemic: 4588 Patients (1.94%), p: 0.001	NA	Pre-Pandemic: 69 Patients (0.2%), Pandemic: 3 Patients (0.4%), p: 0.19	NA	Pre-Pandemic: 1841 Patients (5.5%), Pandemic: 24 Patients (3.5%), p: 0.022	Pre-Pandemic: 53 Patients (0.2%), Pandemic: 0 Patients (0%), p: 0.30

Ramzy J et al. (2022).	NA	NA	Pre-Pandemic: 5 Patients (0.7%), Pandemic: 2 Patients (1.5%), p: 0.31	NA	Pre-Pandemic: 39 Patients (5.2%), Pandemic: 8 Patients (6.1%), p: 0.68	Pre-Pandemic: 2 Patients (0.3%), Pandemic: 1 Patients (0.8%), p: 0.37

Discussion

In the period before the pandemic, there were 25,737 patients who underwent PCI. This number decreased to 21,822 subjects during the pandemic, reflecting a relative decrease of 15.2%. The data illustrates a decline in PCI volumes across all indications from the pre-pandemic to the pandemic period. [1] There were no notable distinctions in the majority of outcomes. Nevertheless, during the pandemic period, the in-hospital mortality rate showed a slight increase (2.0% vs. 1.7%; SMD 2.5%), whereas the prevalence of heart failure (2.2% vs. 1.8%; SMD 2.6%) and myocardial infarction (0.6% vs. 0.4%; SMD 2.1%) was marginally higher in the pre-pandemic cohort. [1]

The overall number of patients receiving PCI declined from 252,194 in 2019 to 236,807 in 2020. There were notable differences in patient characteristics between those treated in 2019 and 2020. Although the variations were generally minor for most variables, patients treated in 2020 exhibited a higher frequency of STEMI presentation (18.3% vs. 17.5%; $p < 0.001$) compared to those treated in 2019. Additionally, patients treated in 2020 were more likely to present with cardiopulmonary arrest (2.12% vs. 2.00%; $p = 0.002$), cardiogenic shock (3.79% vs. 3.45%; $p < 0.001$), and heart failure (4.49% vs. 4.30%; $p = 0.001$). [2]

Among those undergoing PCI for STEMI in 2020, there was a higher prevalence of comorbidities such as hyperlipidemia, diabetes, and renal failure, as well as a more frequent history of PCI, heart failure, and myocardial infarction compared to those treated in 2019. In patients undergoing PCI for STEMI, the incidence of cardiogenic shock was significantly greater in 2020 than in 2019 (13.6% vs. 12.7%; $p < 0.001$), while no significant differences were observed in the occurrence of cardiopulmonary arrest (6.97% vs. 6.77%; $p = 0.26$) and heart failure (13.5% vs. 13.2%; $p = 0.21$). [2]

There was a 43% decrease in the monthly average of primary PCI procedures for STEMI from 2017 to 2019 (865) to 497 in April 2020. There were no significant differences in overall mortality between pre-lockdown and post-lockdown crude in-hospital patient outcomes (3.5% vs. 4.8%, $p=0.12$). However, there was a significant reduction in in-hospital MACE post-lockdown (3.5% vs. 5.5%, $p=0.022$). [3] The percentage of patients with comorbidities such as diabetes, peripheral vascular disease, and cerebrovascular disease remained consistent between the two time frames. There was no notable distinction in the percentage of patients who underwent thrombolysis before PCI (10.3% vs. 7.2%, $p=0.18$).

The average daily number of PCIs for ACS showed no variation between the pre-pandemic and pandemic periods (2.3 vs. 2.4, p=0.61). The distribution of PCI procedures for each subtype of ACS was also comparable across both time periods.[4]

The average weekly count of STEMI PCI procedures showed a significant decrease in the pandemic study period compared to the 2020 pre-pandemic period (73.5 vs. 97.2, p < 0.0001), reflecting a 24% reduction. In high-density counties, the decline between the two periods was 43% (p < 0.0001), whereas in low-density counties, the decrease was only 4% (p = 0.64). [5] There were no discernible differences in in-hospital mortality rates between the two periods for either high-density or low-density counties, but the pandemic period was associated with a shorter mean length of stay in both types of counties.[5]

For STEMI patients, those in the COVID-19 period exhibited a significantly higher BMI (25.5 ± 4.3 kg/m2 vs. 23.3 ± 4.0 kg/m2, P = 0.001) and a higher prevalence of diabetes mellitus (46.2% vs. 29.7%, P = 0.030) compared to those in the control period. Conversely, NSTEMI patients in the COVID-19 period had a numerically higher incidence of diabetes mellitus (61.5% vs. 38.9%, P = 0.14), though this difference was not statistically significant, when compared to those in the control period. In the case of STEMIs, the 30-day mortality rate during the COVID-19 period was 9.4%, and it did not significantly differ from that in the control period (8.3%, P = 0.772).[6]

There was a 19% reduction in the overall count of STEMI patients undergoing primary PCI during the outbreak period. Patients presenting with STEMI exhibited similarities in comorbidities (hypertension, hyperlipidemia, previous history of coronary heart disease, and PCI) in both time periods. However, there was a higher proportion of patients with diabetes and a reduced proportion of old myocardial infarctions in 2020. Among the entire population, cardiac death occurred in 4 patients (1.6%). No significant differences were noted in the incidence of cardiac death, heart failure, and malignant arrhythmia.[8]

Conclusion

There has been a decrease in the number of patients undergoing PCI procedures during the COVID-19 pandemic. Additionally, there has been an increase in several risk factors such as diabetes mellitus and coronary artery disease among patients undergoing PCI during the COVID-19 pandemic. Furthermore, there is no significant difference in the mortality of patients undergoing PCI before and during the COVID-19 pandemic.

Study Limitation

The assessment of overall risk factors and in-hospital mortality for PCI patients both prior to before and during the COVID-19 pandemic in this study encounters several limitations. This systematic review lacks justification for sample size, research settings, and research methodologies when comparing study outcomes, potentially introducing bias due to variations in these aspects. Future research endeavors should prioritize a more meticulous selection process, giving primary consideration to these three factors.

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Conflict of interest

None.

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None.

Author Contribution

Hidtsa Aqila Noor Arasyi and Rizky Pratama collected the data and wrote this research manuscript. Muhammad Hendi Saputra checked the final article result.

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