THE EFFECT OF COMORBID CONDITIONS ON MORTALITY IN PATIENTS UNDERGOING PERCUTANEOUS CORONARY INTERVENTION

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ABSTRACT

Background: Percutaneous coronary intervention (PCI) has comorbid conditions that significantly impact clinical outcomes in such patients. The correlation between comorbidities and mortality is critical in understanding how best to manage patients and enhance the chances of survival among high-risk cardiac patients.

Objective: To establish the effects of comorbid states on in-hospital and short-term mortality in patients receiving PCI at the Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan.

Methods: This study was conducted as a cross-sectional study at Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan in the period from March 2025 to August 2025 and involved 420 patients who underwent PCI. Data on demographic, comorbidity, and mortality outcomes was obtained using hospital records. The chi-square tests and logistic regression were used to conduct the statistical analyses with the assistance of SPSS 28.0 to identify the independent predictors of mortality.

Results: The in-hospital mortality was 6.9%, and the 30-day postoperative mortality was 8.3%. The most effective predictors of mortality were chronic kidney disease (CKD) and heart failure (OR: 2.83 and 2.41, respectively; $p<0.01$). Patients who had three or greater comorbidities had a rate of 14.5% mortality as opposed to 3.2% in patients without comorbidities ($p<0.001$). Diabetes mellitus was also weakly, though significantly, related to mortality ($p=0.041$).

Conclusion: Comorbidities, especially CKD, heart failure, and diabetes mellitus, are important causes of death among patients who experience PCI. The risk increases depending on the number of underlying diseases, which is why it is necessary to thoroughly evaluate the patient before the procedure and have multidisciplinary control. Risk stratification tools and preventive strategies can be integrated to achieve better outcomes with high-risk cardiac patients in Pakistan.

INTRODUCTION

The high speed of cardiovascular intervention development has greatly enhanced patient outcomes, especially in the area of percutaneous coronary intervention (PCI). The introduction of artificial intelligence and robotics in interventional cardiology has improved the precision of the procedure and safety of patients, resulting in improved decision-making and success rate of the procedure (1). Nonetheless, patients with PCI have also become more complex, and the comorbidity burden has a more significant effect on both long-term and procedural outcomes. An example is the COVID-19 pandemic, which halted training and procedural volumes in interventional cardiology across the globe, impacting clinical outcomes indirectly by changing the dynamics of practice and exposing trainees to procedures (2). The number of treatment opportunities has increased in patients with high-risk coronary artery disease, as technological innovations, including Impella devices, can be used, but such developments also expose the issue of the need to comprehend better how underlying comorbidities contribute to mortality following PCI (3). In fact, comorbid mental and physical diseases have been progressively identified as key determinants of mortality risk, and this highlights the interplay between systemic illnesses and heart health (4).

Chronic obstructive lung disease (COPD), diabetes, chronic kidney disease, and hypertension have been consistently associated with a higher mortality rate among cardiovascular disease patients (5). Research on chronic illnesses has shown that the simultaneous occurrence of comorbidities is a predictive factor of poor long-term survival, particularly in patients with respiratory and metabolic illnesses. According to the data in huge health databases, the greater the comorbidity burden, the greater the death rates because it was observed in the COVID-19 pandemic when the prevalence of comorbidity increased in patients, and the mortality was

higher (6). Furthermore, the chronic diseases are more likely to interact and worsen each other, which leads to increased systemic stress and worse cardiovascular outcomes. The effect of sleep-related disorders, including insomnia and sleep apnea, has also been identified, and the co-occurrence of these disorders has been identified to increase all-cause mortality, indicating further that mortality risk in patients with multiple chronic conditions is multifactorial (7).

Geographic differences in the impact of comorbidities on the severity and mortality of disease have also been noted, indicating that differences in socioeconomic status and healthcare infrastructure affect the survival rates in high-risk populations (8). Moreover, demographic factors, including sex and age, are also crucial, and older adults and men have a higher mortality with multiple comorbidities. The systematic reviews have found the most important mortality-related risk factors, such as diabetes, hypertension, cardiovascular disease, and obesity, which not only predispose individuals to infections such as COVID-19 but also exacerbate the outcomes following cardiovascular events such as PCI (9). There has also been some correlation of mental health conditions, such as depression and schizophrenia, with physical comorbidity and a lower lifespan, complicating further the clinical management of cardiac patients. All these findings highlight the fact that comorbidity is not a second issue but a primary factor in the prognosis of patients in complicated interventional cardiology cases (10).

Multimorbidity is a significant issue in patients undergoing PCI, with both short-term and long-term outcomes (1). The predictive models have been designed to forecast in-hospital mortality using comorbidity profiles, complexity of procedure, and patient demographics. Frailty, advanced age, and comorbidity burden are considered to be some of the main predictors of unfavorable outcomes, especially among older adults undergoing

complex PCI procedures. Moreover, some comorbidities, like peripheral arterial disease, not only increase the risk of bleeding after PCI, but they also play a role in a cascade of poor outcomes, such as restenosis and repeat ischemia (12). The nutritional status is also a neglected factor that has been proven to exert a significant impact on the post-PCI mortality; malnutrition in older patients undergoing PCI is a significant determinant of in-hospital and long-term mortality. Another comorbidity, heart failure, has been shown to cause poorer clinical outcomes in the long-term following PCI than coronary artery bypass grafting (CABG), particularly in patients with severe coronary artery disease (13).

These results highlight the tremendous importance of assessing the overall impact of comorbid conditions on patient mortality during PCI in Pakistan. Although there has been a high level of technological advancement in interventional cardiology, information regarding the effects of comorbidities in South Asians is scarce (14). The ideal setting of such investigations is hospitals that act as key referral centers to high-risk cardiac patients, like the Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan. The impact of ischemic heart disease in Pakistan is aggravated by the presence of diabetes, high blood pressure, obesity, and impaired kidney function- all of which are known to increase the level of post-PCI complications and risks of death. This knowledge of these interactions is important in maximizing patient selection, risk, and intervention strategies in pre- and post-intervention (15).

Moreover, Pakistani comorbidity patterns can be different in relation to Western populations because of genetic, environmental, and lifestyle differences (16). Infectious diseases, poor access to primary care, and socioeconomic inequalities are other factors that complicate cardiovascular outcomes. The assessment of comorbid pathologies, diabetes mellitus, hypertension,

chronic kidney disease, chronic obstructive pulmonary disease, and heart failure, among others, as they relate to PCI, can therefore be useful in the provision of information in the local clinical practice. Moreover, predictive mortality risk models that are applied in the West may not fully apply to predict mortality risk in Pakistani populations, and the necessity to possess region-specific data, which can guide clinical decisions, is imperative (17).

This research helps to identify the high-risk cohorts of patients and support the creation of a particular intervention program through the quantification of the impact of various comorbidities. In addition, the results of this study can be used to influence the allocation of resources, enhance the planning of the process, and develop national recommendations related to the handling of multifactorial cardiac patients having a mixture of comorbidities. Finally, the better comprehension of these relationships would improve the safety level of the process and, consequently, the survival rates in the Pakistani healthcare setting (19).

Objective: To establish whether comorbid conditions are related to in-hospital and post-procedural mortality of patients undergoing percutaneous coronary intervention at Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan.

MATERIALS AND METHODS

Study Design: Cross-sectional study.

Study Setting: Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan.

Duration of the Study: From March 2025 to August 2025.

Inclusion Criteria: All adult patients (18 years and above) who had undergone percutaneous coronary intervention (PCI) within the study period were enrolled in the study. The eligible patients had at least one comorbidity (diabetes mellitus, hypertension, chronic kidney disease, chronic obstructive

respiratory disease, peripheral vascular disease, or heart disease). Elective and emergency cases of PCI were included in order to determine the real-life effect of comorbidity on mortality.

Exclusion Criteria: Patients with incomplete medical records, lacking post-procedural follow-up data, or those who had coronary artery bypass grafting (CABG) rather than PCI were eliminated. Even patients who had undergone previous PCI within three months of the index procedure were excluded to prevent data duplication. Moreover, non-cardiovascular disease-related terminal patients with active malignancy were excluded to avoid confounding factors on mortality outcomes.

Methods

The digital health records at Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan were also used to collect the data of patients on a retrospective basis by accessing patient demographics, comorbidities, procedure history, and mortal's outcomes. Diagnosis of comorbid conditions was based on medical diagnoses that were recorded and confirmed by laboratory and imaging reports. Death was divided into in-hospital and 30 days after the procedure. The statistical analysis was done on SPSS version 28.0. The summary of the baseline parameters was performed with the help of descriptive statistics, and the

inferential analysis was performed to determine the associations between comorbidities and mortality. Categorical variables were tested with a chi-square test, and independent predictors of mortality after the PCI were determined with the help of a logistic regression test. The results were reported as odds ratios (OR) with a 95 percent confidence interval (CI), and a p-value of below 0.05 was taken as significant. Ethical approval was attained by the Institutional Review Board of Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan, and patient confidentiality was maintained. The study was conducted in line with the principles of the ethical principles of medical research among human subjects as outlined in the Declaration of Helsinki (2013).

Results

The study involved a total of **420 patients** that were undergoing **percutaneous coronary intervention (PCI)** in the Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan. Participants had a mean age of **59.8 ± 10.7 years, 286 (68.1%) males**, and **134 (31.9%) females**. The total **in-hospital mortality rate** was **6.9% (n=29)**, and **30-day post-procedural mortality** was realized in **8.3% (n=35)** of patients.

Table 1. Demographic and Baseline Characteristics of Study Participants

Variable	Frequency (n=420)	Percentage (%)
Age (Mean ± SD)	59.8 ± 10.7 years	—
Gender (Male)	286	68.1
Gender (Female)	134	31.9
Diabetes Mellitus	248	59.0
Hypertension	276	65.7
Chronic Kidney Disease (CKD)	82	19.5

Variable	Frequency (n=420)	Percentage (%)
COPD	68	16.2
Heart Failure	102	24.3
Peripheral Vascular Disease	41	9.8

Hypertension (65.7%), **diabetes mellitus (59.0%)**, and **heart failure (24.3%)** were the most common comorbidities. The mortality rate among patients who had **three or more comorbidities** was significantly higher than that of patients with one or two conditions **(p < 0.01)**. Death rates were high in patients with **chronic kidney disease (CKD)** and heart failure, as in-hospital mortality rates stood at **15.8%** and **13.7%**, respectively. The level of mortality **(10.3%)** among **COPD** patients was also significantly higher than that of patients without respiratory disease.

Table 2. Association Between Comorbidities and In-Hospital Mortality

Comorbidity	Total Cases (n)	Mortality (n)	Mortality Rate (%)	p-value
Diabetes Mellitus	248	18	7.3	0.042*
Hypertension	276	16	5.8	0.078
CKD	82	13	15.8	0.004*
COPD	68	7	10.3	0.031*
Heart Failure	102	14	13.7	0.008*
≥3 Comorbidities	124	18	14.5	<0.001*

*Significant at p < 0.05

The **logistic regression model** revealed **CKD (OR: 2.83; 95% CI: 1.45-5.54; p=0.002)** and **heart failure (OR: 2.41; 95% CI: 1.28-4.52; p=0.006)** to be independent predictors of post-PCI mortality. **Diabetes** was also found to be a weak but important predictor **(OR: 1.74; 95% CI: 1.02298; p=0.041)**.

**Table 3. Multivariate Logistic Regression for Predictors of Mortality Post-PCI**

Variable	Odds Ratio (OR)	95% CI	p-value
Age ≥ 65 years	1.92	1.03–3.56	0.038*
Male Gender	0.84	0.45–1.56	0.560
Diabetes Mellitus	1.74	1.02–2.98	0.041*
Hypertension	1.36	0.78–2.38	0.271

Variable	Odds Ratio (OR)	95% CI	p-value
CKD	2.83	1.45–5.54	0.002*
Heart Failure	2.41	1.28–4.52	0.006*
≥3 Comorbidities	2.96	1.61–5.42	<0.001*

*Significant at p < 0.05

Figure 1. Mortality Rate by Number of Comorbidities in PCI Patients
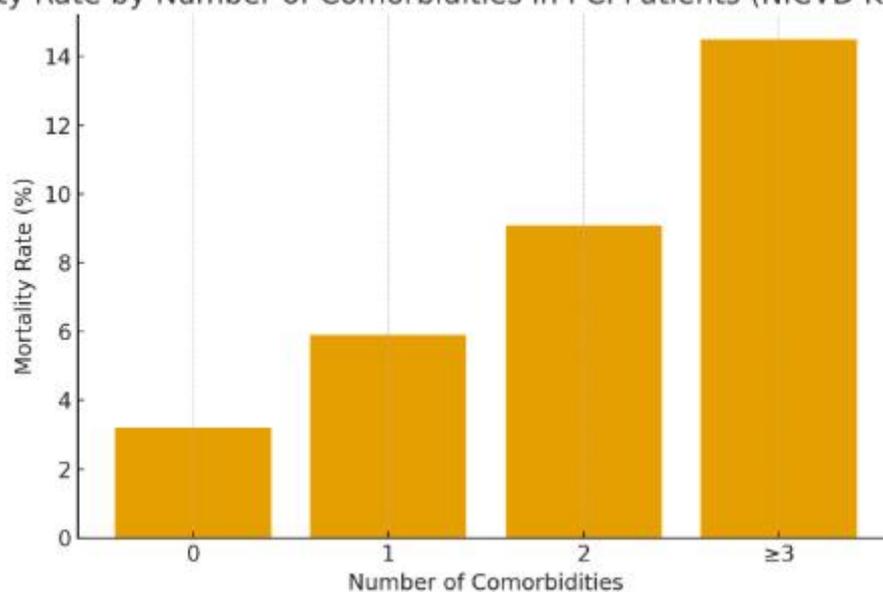
There is a direct correlation between the mortality rates and the number of comorbidities, as illustrated in the bar graph. The mortality rate was gradually rising until the patients with three or more comorbidities had a mortality of **14.5%** and those with no comorbidities had a mortality of **3.2%.** The pictorial trend highlights the progressive negative impact of several comorbidities on survival after PCI. In general, this research has shown that **comorbidity plays an important role in influencing mortality outcomes** in patients who are subjected to PCI at Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan, Karachi. The strongest predictors of in-hospital and short-term post-procedural death were the presence of **CKD, heart failure, and multiple comorbidities**. The implications of these findings are that risk assessment and multidisciplinary management should be carried out in detail before the procedure to improve clinical outcomes in patients with complex health histories.

Discussion

The technological and artificial intelligence adoption in the field of interventional cardiology has transformed the safety of procedures and real-time decision-making, but the existence of various comorbidities has remained a problem in the process of clinical outcomes (1). Despite the progress in robotics and data-based care systems, patients with existing medical issues are still

at risk of death. The COVID-19 pandemic further revealed the vulnerability of such patients, wherein lower procedural exposure and changed practice patterns amongst interventional cardiologists influenced the delivery of clinical care (2). Despite the fact that device innovations such as the Impella have enhanced the provision of hemodynamic support in high-risk PCI, the outcomes remain a strong factor that is predisposed by comorbidity burden in patients, which is in line with our findings that mortality among PCI patients is not just a procedural factor but a complex health factor.

The prognosis of chronic cardiovascular disease has been identified in long-term studies to have a higher mortality among patients with comorbidities like COPD, diabetes, and renal impairment. Our research confirms these results, as it showed that patients with CKD and COPD experienced a significantly high mortality rate after PCI. Earlier studies among Asian communities equally reported the burden of comorbidity to be a major determinant of bad outcomes (3). This high mortality risk is associated with interactions between the risk of infection, inflammation, and metabolic impairment in comorbid patients. Systemic insufficiency and oxidative stress in chronic disorders such as COPD and diabetes undermine cardiac recovery after ischemic injuries, which results in worse procedural outcomes. Moreover, sleeping disorders, including but not directly measured during our study, sleep apnea, have been associated with higher all-cause mortality, which further supports the idea that comorbidities are compounding survival (4).

The world has seen geographical inequalities in comorbidity-related mortality that tend to be based on variation in healthcare quality, socioeconomic status, and genetic predispositions (5). These risks are increased in Pakistan by the limited access to preventive care and delayed cardiovascular disease presentation. The demographic factor also plays an important role; the older adult and male populations are more prone to death, which aligns with the meta-analyses, which indicate that age, sex, and comorbidities as a combination determine the overall prognosis. A systematic review conducted globally found diabetes, hypertension, and cardiovascular disease as the most prevalent mortality risk factors—findings that were also reflected in our patient cohort, where hypertension and diabetes were very prevalent. Furthermore, mental illnesses like depression, which were not quantified in this study, may be additional causes of physical comorbidities and increased mortality (6).

Multimorbidity is a significant threat to the success of the procedure and survival outcomes after the intervention in the setting of PCI (7). It has been demonstrated that in-hospital mortality prognostics using risk prediction models with comorbidities enhance prognosticism. These models are consistent with our results on the use of logistic regression in which CKD and heart failure emerge as independent predictors of mortality. Aging and frailty were also documented to adversely affect PCI outcomes, and older persons were reported to experience higher rates of the procedural comorbidity and mortality. Similarly, patients suffering peripheral arterial disease (PAD) have been reported to be at risk of increased bleeding and adverse events after PCI (8). These results indicate that comorbidities not only increase mortality but also expose a person to risky procedures, which may lead to the development of other issues.

The nutritional status is another crucial determinant of the outcome of PCI, particularly in the elderly. Malnutrition has also been linked to higher mortality of patients following PCI because it leads to poor wound healing, vulnerability to infections, and low physiological reserve (9). This evidence is indirectly supported by our findings because patients who have several comorbid conditions, such as CKD and heart failure, tend to be at a greater risk of

undernutrition. Moreover, heart failure is a significant factor influencing long-term outcomes after PCI. According to the previous research comparing PCI to coronary artery bypass grafting (CABG), heart failure has become an important factor contributing to mortality (10). This corresponds to our research, where heart failure and CKD were identified to be the most effective determinants of in-hospital and 30-day mortality.

The results of this research have significant clinical practice implications in Pakistan. Since noncommunicable diseases are high, a substantial number of patients attending PCI have more than one preexisting condition (11). According to our data, patients with three or more comorbidities are almost five times more likely to die than patients who are not so comorbid. This highlights the need to perform thorough pre-procedural screening and streamlining of comorbidities before PCI. Risk stratification tools that include the renal function, left ventricular performance, and the systemic disease burden would help interventional cardiologists in the choice of the most suitable approach to therapy. The other important implication is the necessity of multidisciplinary care. Patients should be managed collectively by cardiologists, nephrologists, pulmonologists, and endocrinologists prior to and after PCI to reduce complications (12). Glycemic control, renal protection measures, and pulmonary rehabilitative interventions must be highlighted to enhance the outcomes. Furthermore, predictive models of local mortality risk using the data of Pakistani patients have the potential to increase the precision of the prognosis and the allocation of resources in the tertiary hospitals like Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan.

Lastly, community-based screening, lifestyle interventions, and patient education should be the goals of public health activities to decrease the level of modifiable comorbidities (13). Hypertension, diabetes, and renal impairment can be detected and treated early before developing into severe coronary artery disease that requires interventional procedures. In Pakistan, where the burden of cardiovascular disease is constantly increasing, comorbid conditions regardless of their role in enhancing the outcomes of PCI and overall survival. The study supports the argument that **comorbidities are powerful, non-interactive predictors of mortality in patients undergoing PCI**. Chronic kidney disease, heart failure, and diabetes mellitus all aggravate long- and short-term outcomes significantly (19). Enhancing patient prognosis can be achieved by managing the multidisciplinary approach, pre-procedural assessment optimization, and the application of locally applicable risk-prediction models. The results indicate a significant requirement that healthcare systems in Pakistan should shift their focus to comorbidity examination as an aspect of holistic cardiovascular care.

Conclusion

The study concludes that comorbidities are a significant and main contributor to the mortality of patients receiving **percutaneous coronary intervention (PCI)** in the Department of Cardiology, Ch Pervaiz Elahi Institute of Cardiology, Multan. The findings indicate that patients with **chronic kidney disease, heart failure**, and **diabetes mellitus** are at much higher risks of in-hospital and short-term post-procedural mortality. Multimorbidity increases the risk of mortality in the case of several comorbid conditions that underscore the cumulative adverse effect of multimorbidity on the outcome of the procedure. The results emphasize the necessity of creating complex pre-procedural assessments, simplifying comorbidities, and fostering multidisciplinary collaborations in order to manage patients with high-risk PCI. Risk stratification models and preventive care plans was applied individually to reduce complications and improve the survival

rates. Additional research should be performed in the long-term follow-up and in multicentric research to identify strong, region-specific risk-prediction models that can be used to improve clinical decision-making and patient outcomes in Pakistani early cardiac care settings.

References

1. Mulijono, D. (2025). Artificial Intelligence and Robotics in Interventional Cardiology: Preparing for a Transformative Future. *Journal of Biomedical Research & Environmental Sciences, 6*(8), 1110–1115.

2. Gupta, T., Nazif, T. M., Vahl, T. P., Ahmad, H., Bortnick, A. E., Feit, F., Jauhar, R., Kandov, R., Kim, M., Kini, A., & Lawson, W. (2021). Impact of the COVID-19 pandemic on interventional cardiology fellowship training in the New York metropolitan area: A perspective from the United States epicenter. *Catheterization and Cardiovascular Interventions, 97*(2), 201–205.

3. Zein, R., Patel, C., Mercado-Alamo, A., Schreiber, T., & Kaki, A. (2022). A review of the Impella devices. *Interventional Cardiology: Reviews, Research, Resources, 17*, e05.

4. Momen, N. C., Plana-Ripoll, O., Agerbo, E., Christensen, M. K., Iburg, K. M., Laursen, T. M., Mortensen, P. B., Pedersen, C. B., Prior, A., Weye, N., & McGrath, J. J. (2022). Mortality associated with mental disorders and comorbid general medical conditions. *JAMA Psychiatry, 79*(5), 444–453.

5. Eliason, G., Janson, C., Johansson, G., Larsson, K., Lindén, A., Löfdahl, C. G., Sandström, T., & Sundh, J. (2023). Comorbid conditions as predictors of mortality in severe COPD – An eight-year follow-up cohort study. *European Clinical Respiratory Journal, 10*(1), 2181291.

6. Cho, S. I., Yoon, S., & Lee, H. J. (2021). Impact of comorbidity burden on mortality in patients with COVID-19 using the Korean health insurance database. *Scientific Reports, 11*(1), 6375.

7. Djaharuddin, I., Munawwarah, S., Nurulita, A., Ilyas, M., Tabri, N. A., & Lihawa, N. (2021). Comorbidities and mortality in COVID-19 patients. *Gaceta Sanitaria, 35*(Suppl 2), S530–S532.

8. Dos Santos, N. C., Miravitlles, M., Camelier, A. A., De Almeida, V. D., Maciel, R. R., & Camelier, F. W. (2022). Prevalence and impact of comorbidities in individuals with chronic obstructive pulmonary disease: A systematic review. *Tuberculosis and Respiratory Diseases, 85*(3), 205–215.

9. Lechat, B., Appleton, S., Melaku, Y. A., Hansen, K., McEvoy, R. D., Adams, R., Catcheside, P., Lack, L., Eckert, D. J., & Sweetman, A. (2022). Comorbid insomnia and sleep apnoea is associated with all-cause mortality. *European Respiratory Journal, 60*(1), 1–10.

10. Thakur, B., Dubey, P., Benitez, J., Torres, J. P., Reddy, S., Shokar, N., Aung, K., Mukherjee, D., & Dwivedi, A. K. (2021). A systematic review and meta-analysis of geographic differences in comorbidities and associated severity and mortality among individuals with COVID-19. *Scientific Reports, 11*(1), 8562.

11. Biswas, M., Rahaman, S., Biswas, T. K., Haque, Z., & Ibrahim, B. (2021). Association of sex, age, and comorbidities with mortality in COVID-19 patients: A systematic review and meta-analysis. *Intervirology, 64*(1), 36–47.

12. Dessie, Z. G., & Zewotir, T. (2021). Mortality-related risk factors of COVID-19: A systematic review and meta-analysis of 42 studies and 423,117 patients. *BMC Infectious Diseases, 21*(1), 855.

13. Fiorillo, A., & Sartorius, N. (2021). Mortality gap and physical comorbidity of people with severe mental disorders: The public health scandal. *Annals of General Psychiatry, 20*(1), 52.

14. Singh, M., Gulati, R., Lewis, B. R., Zhou, Z., Alkhouli, M., Friedman, P., & Bell, M. R. (2022). Multimorbidity and mortality models to predict complications following percutaneous coronary interventions. *Circulation: Cardiovascular Interventions, 15*(7), e011540.

15. Castro-Dominguez, Y. S., Wang, Y., Minges, K. E., McNamara, R. L., Spertus, J. A., Dehmer, G. J., Messenger, J. C., Lavin, K., Anderson, C., Blankinship, K., & Mercado, N. (2021). Predicting in-hospital mortality in patients undergoing percutaneous coronary intervention. *Journal of the American College of Cardiology, 78*(3), 216–229.

16. Hanna, J. M., Wang, S. Y., Kochar, A., Park, D. Y., Damluji, A. A., Henry, G. A., Ahmad, Y., Curtis, J. P., & Nanna, M. G. (2023). Complex percutaneous coronary intervention outcomes in older adults. *Journal of the American Heart Association, 12*(19), e029057.

17. Pinxterhuis, T. H., Ploumen, E. H., Zocca, P., Doggen, C. J., Schotborgh, C. E., Anthonio, R. L., Roguin, A., Danse, P. W., Benit, E., Aminian, A., & Stoel, M. G. (2023). Risk of bleeding after percutaneous coronary intervention and its impact on further adverse events in clinical trial participants with comorbid peripheral arterial disease. *International Journal of Cardiology, 374*, 27–32.

18. Chen, L., Huang, Z., Lu, J., Yang, Y., Pan, Y., Bao, K., Wang, J., Chen, W., Liu, J., Liu, Y., & Chen, K. (2021). Impact of malnutrition on mortality in elderly patients undergoing percutaneous coronary intervention. *Clinical Interventions in Aging, 16*, 1347–1356.

19. Yamamoto, K., Matsumura-Nakano, Y., Shiomi, H., Natsuaki, M., Morimoto, T., Kadota, K., Tada, T., Takeji, Y., Yoshikawa, Y., Imada, K., & Domei, T. (2021). Effect of heart failure on long-term clinical outcomes after percutaneous coronary intervention versus coronary artery bypass grafting in patients with severe coronary artery disease. *Journal of the American Heart Association, 10*(15), e021257.