

The Relationship between Comorbidities and Mortality among Covid-19 Patients at Raden Mattaher General Hospital in Jambi

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Keywords:

COVID-19, Comorbidities,
Mortality

Abstract

Coronavirus Disease 2019 (COVID-19) remains a major global health challenge, particularly among hospitalized patients with underlying comorbidities that increase the risk of severe complications and mortality. Identifying the relationship between comorbid diseases and mortality is essential to improve risk stratification and clinical management, especially in regional referral hospitals. This study aimed to analyze the relationship between comorbidities and mortality among COVID-19 patients treated at Raden Mattaher General Hospital, Jambi. Methods: An observational analytic study with a retrospective cross-sectional design was conducted using secondary data from the medical records of 294 laboratory-confirmed COVID-19 patients hospitalized between May 2020 and December 2021. Data were analyzed using univariate statistics to describe patient characteristics and the Chi-square test to determine the association between comorbidities and mortality, with a significance level of $p < 0.05$. The majority of patients were aged 56–64 years (27.6%) and male (54.4%). Half of the patients (50.0%) had at least one comorbidity, with diabetes mellitus (21.1%) being the most prevalent, followed by hypertension (10.2%) and chronic kidney disease (9.2%). Overall mortality was 15.3%. Patients with comorbidities experienced a significantly higher mortality rate (21.1%) than those without comorbidities (9.5%). Statistical analysis demonstrated a significant association between comorbid diseases and mortality ($p = 0.006$). Comorbidities are significantly associated with increased mortality among hospitalized COVID-19 patients. Early identification and comprehensive management of patients with underlying diseases are crucial to reducing mortality and improving clinical outcomes.

INTRODUCTION

Coronavirus Disease 2019 (COVID-19) is an infectious disease caused by Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), a positively polarized single-stranded RNA virus from the family Coronaviridae. The virus was first identified in Wuhan, China, in December 2019, and quickly spread globally. The WHO designated the COVID-19 virus outbreak as a global pandemic on March 11, 2020, after previously declaring it a Public Health Emergency of International Concern (PHEIC) on January 30, 2020 (Alkautsar, 2021).

COVID-19 presents a diverse clinical spectrum, ranging from asymptomatic to severe symptoms. Common symptoms are fever, cough, and shortness of breath, in severe cases can develop into pneumonia, ARDS, kidney failure, and death, with an average incubation period of 5–6 days and a maximum of 14 days (Kementerian Kesehatan Republik Indonesia, 2020; Raharja et al., 2023).

The various risk factors reported to be associated with COVID-19 severity are the most common gender, elderly, and comorbidities. 75% of hospitalized patients with COVID-19 have at least one comorbidity among which are hypertension, diabetes, cancer, neurodegenerative diseases, cardiovascular disease, obesity, and kidney disease (Silaghi-Dumitrescu et al., 2023).

Various studies show that patients with comorbid diseases have a higher risk of mortality compared to patients without comorbidities. Conditions such as diabetes mellitus, hypertension, and chronic kidney disease are comorbidities that are often found in COVID-19 patients can increase the severity of infection through various mechanisms, such as impaired immune regulation, increased systemic inflammation, endothelial dysfunction, coagulation disorders, hyperactivation of the RAAS pathway (Menon et al., 2021). As well as increased expression of ACE-2 which is the entrance for SARS-CoV-2 into cells. These conditions increase the risk of severe complications such as acute respiratory failure, sepsis, and multiorgan failure that led to mortality of COVID-19 patients (Nigatu & Dessie, 2025).

In addition to the comorbidities already mentioned, the involvement of kidney organs in COVID-19 patients is also an important concern. The incidence of acute kidney disorder in COVID-19 patients is reported to range from 5–15% and increases significantly in patients with severe conditions. Acute kidney disorders in COVID-19 can occur due to various mechanisms, such as hypoxemia, hypovolemia, systemic inflammatory responses, and the use of nephrotoxic drugs (Chávez-Valencia et al. 2022; Pecly et al. 2021; Wishahi et al. 2022). In addition, SARS-CoV-2 can enter kidney cells through ACE-2 receptors that are widely expressed in kidney tissue, thus contributing to kidney damage directly or indirectly. Some studies have also shown that acute kidney disorders are associated with increased disease severity and mortality in COVID-19 patients. Therefore, kidney involvement, especially acute kidney disorders, is an important factor that needs to be considered in determining the prognosis of COVID-19 patients (Menon et al., 2021).

Globally, as of December 13, 2023, there were 772,386,069 confirmed cases of COVID-19 with 6,987,222 deaths. The results of the systematic review showed that the most common comorbidities found in COVID-19 patients were hypertension with a prevalence of around 20–22%, followed by diabetes mellitus at 9–11% and cardiovascular disease at 5–9%. In addition, the prevalence of other comorbidities such as cancer, COPD, cerebrovascular disease, and chronic kidney disease was reported at 3.9%, 3.1%, 3.0%, and 2.4%, respectively (Nigatu & Dessie, 2025).

Indonesia reported the first case from March 2, 2020 to December 31, 2020, with 743,198 confirmed cases in Indonesia and 22,138 deaths with a CFR of 3.0% (Kementerian Kesehatan Republik Indonesia, 2021). The first case as of December 31, 2021, recorded 4,262,720 confirmed cases in Indonesia and 144,094 deaths with a CFR of 3.4% (Kementerian Kesehatan Republik Indonesia, 2022).

Based on medical record data at Raden Mattaher Jambi Hospital, it shows a significant increase in the number of COVID-19 cases and deaths during the 2020–2021 period. In 2020, there were 262 positive cases with 37 deaths, while in 2021 it increased to 1199 cases with 198 deaths. Of the total, there were 167 COVID-19 patients who were treated for comorbid diseases, including diabetes mellitus as many as 104 patients, hypertension 24 patients, chronic kidney disease 27 patients, and acute kidney disorders 12 patients. In addition, there were differences in mortality rates between comorbidities, namely in diabetes mellitus as many as

21 deaths, hypertension 1 death, chronic kidney disease 12 deaths, and acute kidney disorders 8 deaths. These data suggest that comorbidities, particularly kidney disorders, have a tendency to increase the risk of death in COVID-19 patients (Cai et al. 2021; Portoles et al. 2020; Wang et al. 2020).

Although the relationship between comorbid diseases and mortality in COVID-19 patients has been widely reported, studies that specifically analyze the relationship between comorbid diseases and mortality in COVID-19 patients at Raden Mattaher Jambi Hospital are still limited.

Based on this background, it can be concluded that the presence of comorbidities can increase mortality higher in COVID-19 patients, but local data, especially in Jambi Province, are still limited. Therefore, this study was conducted to further study the "The relationship between comorbid diseases and mortality in COVID-19 patients at Raden Mattaher Jambi Hospital".

This study examines the relationship between comorbid diseases and mortality of COVID-19 patients at Raden Mattaher Jambi Hospital. In general, the study aims to analyze the relationship between the two variables, with specific objectives including the identification of the distribution of patient characteristics based on age and sex, the distribution of comorbid diseases, the distribution of mortality, and the analysis of the relationship between comorbidities and mortality. The results of the research are expected to benefit researchers in deepening clinical understanding, for educational institutions as an additional scientific reference in the library of the FKIK University of Jambi, and for future researchers as a basis for the development of similar studies in the future.

METHOD

This study was an observational analytical study with a retrospective approach using a cross sectional design, which aims to analyze the relationship between comorbid diseases and mortality of COVID-19 patients for the period May 2020 to December 2021 at Raden Mattaher Jambi Hospital. The study was conducted from May to June 2026 with the population of all patients diagnosed with COVID-19 treated during that period. Samples were selected based on inclusion criteria, i.e. patients with a confirmed diagnosis of COVID-19 through RT-PCR or antigen tests and had complete comorbid data and mortality status, while patients with incomplete medical records or having two or more comorbidities were excluded. The sample size was calculated using a categorical unpaired analytical formula and a minimum of 133 samples per group were obtained.

Data is collected from the patient's medical records as secondary data, then processed through the stages of editing, coding, tabulating, data entry, and cleaning. Data analysis was carried out univariate to describe the distribution of patient characteristics, as well as bivariate using the Chi-square test or Fisher's Exact Test if the Chi-square requirements were not met, with the help of SPSS software. Before the research was carried out, the researcher first obtained an ethics permit from the Faculty of Medicine and Health Sciences, University of Jambi and official approval from the Raden Mattaher Jambi Hospital.

RESULTS AND DISCUSSION

The research has been conducted in the Medical Record Room of Raden Mattaher Jambi Hospital. This study uses secondary data, namely medical record data of COVID-19 patients at Raden Mattaher Jambi Hospital. In this study, there were 294 medical record data of patients diagnosed with COVID-19 in the period May 2020 - December 2021.

In this study sample, a univariate analysis was conducted to assess the distribution of patient characteristics based on age, sex, comorbid diseases, and mortality. In addition, bivariate analysis was also carried out to determine the relationship between comorbid diseases and mortality in COVID-19 patients.

Analysis of COVID-19 Patient Characteristics by Age

Table 1. Characteristics of COVID-19 patients by age

Characteristics of Research Subjects	Total	
	n	%
Age		
17-25	12	4.1
26-35	33	11.2
36-45	36	12.2
46-55	79	26.9
56-64	81	27.6
>65	53	18.0
Total	294	100

The age category is divided into 6 groups, namely 17-25, 26-35, 36-45, 46-55, 56-64, and >65 years. The results showed that the most age range in COVID-19 patients was 56-64 years old as many as 81 patients (27.6%), followed by the age range of 46-55 years as many as 79 patients (26.9%), the age range of > 65 years as many as 53 patients (18.0%), the age range of 36-45 years as many as 36 patients (12.2%), the age range of 26-35 years as many as 33 patients (11.2%), and in the age range of 17-25 years as many as 12 patients (4.1%).

Analysis of COVID-19 Patient Characteristics by Gender

Table 2. Characteristics of COVID-19 patients by sex

Characteristics of Research Subjects	Total	
	n	%
Gender		
Male	160	54.4
Women	134	45.6
Total	294	100

The gender category is divided into 2 groups, namely the male and female genders. The results showed that the most gender found in COVID-19 patients was 160 patients (54.4%) in men, while in women as many as 134 patients (45.6%).

Analysis of COVID-19 Patient Characteristics Based on Comorbid Diseases

Table 3. Characteristics of COVID-19 patients by comorbid disease

Characteristics of Research Subjects	Total	
	n	%
Diabetes Melitus	62	21.1
Hypertension	30	10.2
Chronic Kidney Disease	27	9.2
Acute Kidney Disorders	7	2.4
TB Published	5	1.7
Hypertension Heart Disease	15	5.1
Total	294	100

The results showed that as many as 147 patients (50.0%) had comorbidities, while 147 patients (50.0%) had no comorbidities. The most common comorbid diseases were diabetes mellitus in 62 patients (21.1%), followed by hypertension in 30 patients (10.2%), chronic kidney disease in 27 patients (9.2%), hypertension in 15 patients (5.1%), acute kidney disease in 7 patients (2.4%), and pulmonary TB in 5 patients (1.7%).

Analysis of COVID-19 Patient Characteristics Based on Mortality

Table 4. Characteristics of COVID-19 patients by mortality

Characteristics of Research Subjects	Total	
	n	%
Status Mortalities		
Died	45	15.3
Life	249	84.7
Total	294	100

The results showed that 45 patients (15.3%) died of COVID-19 patients, while 249 patients (84.7%) survived.

Patient Characteristics by Age

Patients diagnosed with COVID-19 in this study showed that the age group of 56-64 years was the most found as many as 81 patients (27.6%) while the age group with the least number of patients was found in the age group of 17-25 years, which was as many as 12 patients (4.1%). Patients aged 56-64 years have a high risk of being infected with COVID-19, because as they age, the immune system tends to weaken, making it more difficult to fight infections and in old age it is also found to be comorbid, so the risk of being infected with COVID-19 is greater.

The results of this study are in line with the research conducted by Vermonte and Wicaksono (2020), it was found that the largest proportion of COVID-19 patients in Indonesia are in the age range of 50-59 years which as a whole amounts to (20.9%) of the total positive cases of COVID-19. In addition, research conducted by Salsabila et al. (2023) shows that the majority of COVID-19 patients are aged ≥ 60 years old as many as 809 people (39.5%), Then the age of 56-59 years was 759 people (37.1%). Elderly age is known to be one of the risk factors for worsening conditions in COVID-19 patients. As a person ages, the function of the immune system will decrease due to degenerative processes so that the body becomes more susceptible to SARS-CoV-2 infection (Salsabila et al., 2023).

The results of this study are not in line with the research conducted by Marsika et al, showing that the most COVID-19 patients are in adults aged 26-45 years. In the adult age

group, they tend to have the potential to contract COVID-19 because the productive age has a higher potential to interact socially compared to other age groups. In addition, in the study conducted by Rahmawati et al., the majority of COVID19 patients with the highest age were 35-54 years old with a frequency of 42 patients (45%), because people of productive age are more active outside the home, so they will be exposed more often. At this productive age, people are more susceptible to various diseases.

According to the researchers, the dominance of the 56–64-year-old age group in this study shows that the elderly group has a higher vulnerability to COVID-19 infection. This is related to the process of *immunosenescence* which causes a decrease in immune system function, so that the body's response to SARS-CoV-2 infection becomes less effective. In addition, in this age group, comorbid diseases are more often found that can aggravate the course of the disease and increase the need for hospital care.

Patient Characteristics by Gender

The results showed that COVID-19 patients were more male, namely 160 patients (54.4%), while women were 134 patients (45.6%). These results show that there are more male patients than women. Male patients are more susceptible to COVID-19 infection because sex hormones in men are thought to increase the expression of the ACE-2 receptor which is the entry point of the SARS-CoV-2 virus, thereby increasing susceptibility to infection. In addition, testosterone also has immunosuppressive effects that can inhibit the formation of antibody responses.

These findings are in line with the 2020 Indonesian Health Profile which reports that more confirmed cases of COVID-19 nationally are found in men than women in almost all age groups. The results of this study are in line with research conducted by Djaharuddin et al. (2021), showing that men dominate COVID-19 cases by 66.67%. Male sex increases the risk of COVID-19 compared to women. The difference in hormone levels between men and women is theorized to be the reason why men are more susceptible to COVID-19. The hormone estrogen in women has immunomodulatory effects that can increase the immune response to viral infections. In addition, men are known to have higher levels of ACE-2 receptors, thus increasing the viral load of COVID-19 in men (Drew & Adisasmita, 2021).

The results of the study are not in line with the research conducted by Khaerunnisa et al., female patients have a proportion of 50.9%. This can be affected because women are more easily stressed in facing something new. In addition, the research conducted by Awalia et al., whose research results are that men are better able to deal with stress or something new without excessive emotions and with lower levels of anxiety than women.

According to the researchers, the dominance of male patients in this study shows that biologically, the hormone testosterone has an immunosuppressive effect, while estrogen in women plays a role in increasing immune system activity.

Patient Characteristics Based on Comorbid Disease

Based on the results of the analysis of the distribution of comorbid diseases in COVID-19 patients, 147 patients (50.0%) had comorbidities, while as many as 147 patients (50.0%), had no comorbidities. The most common type of comorbid disease was diabetes mellitus in 62 patients (21.1%), followed by hypertension in 30 patients (10.2%), chronic kidney disease in 27 patients (9.2%), hypertension in 15 patients (5.1%), acute kidney disease in 7 patients (2.4%), and pulmonary TB in 5 patients (1.7%).

Diabetes mellitus was the most common comorbid in the study. Patients with diabetes mellitus are more susceptible to COVID-19 infection due to an increase in ACE-2 so that the virus attaches and replicates a lot, the occurrence of immune dysfunction in diabetes mellitus causing cytokine storms that cause severity and death COVID-19 (Salsabila et al., 2023). Hypertensive patients tend to have a higher number of ACE-2 receptors, making it easier for the SARS-CoV-2 virus to spread in the body. Kidney disease is experiencing severity and mortality because the SARS-CoV-2 virus can target kidney cells (Guan et al., 2020). It is also related to chronic inflammatory conditions in chronic kidney disease characterized by increased pro-inflammatory cytokines and oxidative stress. These conditions can interfere with immune system function, thereby increasing susceptibility to viral infections (Cai et al., 2021). Cardiovascular disease is on the rise in COVID-19 patients. Impaired cardiac efficiency in pumping blood can increase the load on the overall immune system, leading to a weaker immune response in patients with cardiovascular disease. Patients with TB also show high ACE-2 expression, so it was found that TB infection can increase the risk of SARS-CoV-2 not only through immunosuppressive states but also through increased ACE-2 expression.

The results of this study are in line with the research conducted by Fathi et al, the prevalence of people with comorbidities, namely (45.98%). The most common prevalence of comorbidities was 28.30% for hypertension, (14.29%) for diabetes, (12.30%) for cardiovascular disease, and (5.19%) for chronic kidney disease. In addition, in a study conducted by Pradhevi et al., it was shown that most patients had multiple comorbidities (71.3%), 23.5% had one comorbidity and only 5.3% had no comorbidities. The most common comorbidities were diabetes mellitus (82.7%), chronic kidney disease (43.0%), hypertension (25.7%), and obesity (23.6%). Patients with diabetes mellitus and hypertension will have decreased resistance to viral infections. Patients with diabetes mellitus and long-term hypertension are more susceptible to the development of critical illness in COVID-19 because these conditions can worsen heart function and damage the structure of blood vessels.

According to researchers, diabetes mellitus is the most comorbid due to its high prevalence in the adult and elderly age groups. Chronic hyperglycemia causes impaired immune function, increased oxidative stress, and systemic inflammation so that people with diabetes are more susceptible to COVID-19 infection. Meanwhile, hypertension and chronic kidney disease are also often found because both diseases are widely found in the elderly population and are closely related to RAAS disorder which plays a role in the pathogenesis of COVID-19.

Patient Characteristics Based on Mortality

The results showed that there were 45 COVID-19 patients who died (15.3%). Mortality in COVID-19 patients is influenced by various factors, such as advanced age, male sex, and the presence of comorbid diseases (Muryanto, 2021).

The results of this study are in line with the research conducted by Hartanti et al., which reported a CFR of (14.9%) in patients hospitalized in the first 10 months of the COVID-19 pandemic. Higher mortality rates were observed in the first 3 months of the pandemic and were associated with old age, comorbidities, and severe illness. In addition, the results of a study conducted by Surendra et al., reported a higher or similar CFR among hospitalized COVID-19 patients in the early phase of the pandemic in Jakarta, Indonesia, reporting lower mortality rates (9.4% and 12%).

The results of the study are also in line with research conducted by Saputra et al. (2022), which stated that one of the main causes of death in COVID-19 patients is ARDS. The cause of ARDS is due to a cytokine storm which is an uncontrolled systemic inflammatory response due to the release of large amounts of pro-inflammatory cytokines. This excessive immune response will cause lung damage and fibrosis so that functional disability occurs. In addition to ARDS, cytokine storms can also cause sepsis, myocarditis, and multiorgan failure (Saputra et al., 2022).

According to researchers, ARDS is the main mechanism underlying mortality in COVID-19 patients. Excessive inflammatory responses in the form of cytokine storms cause diffuse damage to the alveolus, gas exchange disorders, and acute respiratory failure. The condition can develop into multiorgan failure which ultimately increases the risk of mortality.

Analysis of the Relationship between Comorbid Diseases and Mortality in COVID-19 Patients

Table 5. Relationship between comorbid diseases and mortality of COVID-19 patients

Comorbid Diseases	Status Mortalitas						p-value
	Life		Died		Total		
	n	%	n	%	n	%	
There are Comorbidities	116	78.9	31	21.1	147	100	0.006
No Comorbidities	133	90.5	14	9.5	147	100	
Total	249	84.7	45	15.3	294	100	

The results showed that 31 patients with comorbidities died and 116 patients did not die (78.9%). As for patients who did not have comorbidities, 14 people died (9.5%) and those who did not die were 133 people (90.5%). Based on the results of bivariate analysis using the Chi-Square test to determine the relationship between comorbid diseases and mortality in COVID-19 patients, the results showed that the value was $p=0.006$ ($p<0.05$), so it can be concluded that there is a statistically significant relationship between comorbid diseases and mortality in COVID-19 patients at Raden Mattaher Jambi Hospital. Patients with comorbid diseases tend to have worse clinical outcomes compared to patients without comorbidities, this condition is related to decreased immune function, chronic inflammation, and limited physiological reserves of the body in the face of infection.

The results of this study are in line with the study conducted by Guan et al. (2020), where out of 1590 patients in China, 399 of them had at least one comorbid disease, while the other 130 patients had two or more comorbid diseases. The results of the study show that comorbid disease is a condition that is often found in COVID-19 patients, the presence of comorbidities is known to aggravate the patient's condition because it causes immune dysregulation and chronic inflammation so that the body is more susceptible to severe infection due to SARS-CoV-2 (Guan et al., 2020). In addition, the results of this study are in line with research conducted by Azzahra et al., showing that COVID-19 patients with comorbidities died more (76.9%) compared to non-comorbid patients (23.1%), the Chi-Square test obtained a $P<0.001$ ($P<0.05$) score, indicating that the type of comorbidity has a significant relationship with mortality status. Previous studies have shown that comorbidities contribute to a decrease in the body's functional reserves, thereby reducing the capacity and ability to fight infections. Certain

comorbidities are related to the expression of ACE-2 receptors that increase the entry of the virus into the host cell. Comorbidities cause COVID-19 patients to be substantially associated with significant morbidity and mortality (Herlina et al., 2022).

According to the researchers, the results of this study show that patients with comorbidities have physiological conditions that have experienced decreased organ function and immune dysregulation before being infected. This causes the response to infection to be inadequate, making it easier for the virus to develop into severe conditions. In addition, researchers also assess that certain comorbidities such as diabetes, hypertension, and chronic kidney disease can amplify systemic inflammatory processes and accelerate the occurrence of cytokine storms, this condition ultimately increases the risk of ARDS and mortality.

Research Limitations

1. There are medical record data that are incomplete, difficult to read, lost, or not found, so as to affect the results of the research.
2. This study only focused on comorbid factors and patient characteristics in the form of age and gender. In addition, there are still the possibility of other confounding variables that have not been studied, such as smoking status, time of disease onset, laboratory test results, and the severity of COVID-19 that can affect patient outcomes.

CONCLUSION

Based on the results of the study on the relationship between comorbid diseases and mortality in COVID-19 patients at Raden Mattaher Jambi Hospital for the period May 2020-December 2021, it can be concluded as follows: The characteristics of the most COVID-19 patients were found in the age group of 56–64 years as many as 81 patients (27.6%), and more in the male gender as many as 160 patients (54.4%). COVID-19 patients have comorbid diseases including diabetes mellitus (21.1%), hypertension (10.2%), chronic kidney disease (9.2%), hypertensive heart disease (5.1%), acute kidney disorders (2.4%), and pulmonary TB (1.7%). Mortality in COVID-19 patients at Raden Mattaher Jambi Hospital was 15.3%, while 84.7% of patients were declared alive. There was a significant relationship between comorbid diseases and mortality in COVID-19 patients at Raden Mattaher Jambi Hospital with a value of $p=0.006$ ($p<0.05$). For future researchers, it is recommended to research other factors that can affect the mortality of COVID-19 patients, such as the severity of the disease, the length of treatment and the results of laboratory examinations.

REFERENCES

- Alkautsar, A. (2021). Hubungan penyakit komorbid dengan tingkat keparahan pasien COVID-19. *Jurnal Medika Hutama*, 3(1), 1488–1494.
- Cai, R., Zhang, J., Zhu, Y., Liu, L., Liu, Y., & He, Q. (2021). Mortality in chronic kidney disease patients with COVID-19: A systematic review and meta-analysis. *International Urology and Nephrology*, 53(8), 1623–1629. <https://doi.org/10.1007/s11255-021-02867-8>
- Chávez-Valencia, V., Orizaga-de-la-Cruz, C., & Lagunas-Rangel, F. A. (2022). Acute kidney injury in COVID-19 patients: Pathogenesis, clinical characteristics, therapy, and mortality. *Diseases*, 10(3), 53. <https://doi.org/10.3390/diseases10030053>
- Djaharuddin, I., Munawwarah, S., Nurulita, A., Ilyas, M., Tabri, N. A., & Lihawa, N. (2021). Penyakit penyerta dan kematian pada pasien COVID-19. *Gaceta Sanitaria*, 35(Suppl.

- 2), S530–S532.
- Drew, C., & Adisasmita, A. C. (2021). Gejala dan komorbid yang memengaruhi mortalitas pasien positif COVID-19 di Jakarta Timur, Maret–September 2020. *Tarumanagara Medical Journal*, 3(1), 42–51.
- Guan, W. J., Liang, W. H., Zhao, Y., Liang, H. R., Chen, Z. S., Li, Y. M., et al. (2020). Comorbidity and its impact on 1,590 patients with COVID-19 in China: A nationwide analysis. *European Respiratory Journal*, 55(5). <https://doi.org/10.1183/13993003.00547-2020>
- Herlina, H., Nugroho, A. P. D., Maemun, S., Pertiwi, I., Nanda, A. D. I. S., & Murtiani, F. (2022). Kematian pada pasien COVID-19 berdasarkan komorbid dan tingkat keparahan. *Indonesian Journal of Infectious Disease*, 8(1), 44–54.
- Kementerian Kesehatan Republik Indonesia. (2022). *Profil kesehatan Indonesia tahun 2021*. Kementerian Kesehatan Republik Indonesia.
- Menon, T., Sharma, R., Kataria, S., Sardar, S., Adhikari, R., Tousif, S., et al. (2021). The association of acute kidney injury with disease severity and mortality in COVID-19: A systematic review and meta-analysis. *Cureus*, 13(3), e13894. <https://doi.org/10.7759/cureus.13894>
- Muryanto, I. (2021). Kematian akibat COVID-19 di Kabupaten Rokan Hulu: Studi epidemiologi deskriptif. *Jurnal Kesehatan Komunitas*, 7(3), 381–386.
- Nigatu, B. Z., & Dessie, N. T. (2025). Prevalence of comorbidities and their association with disease severity and mortality in COVID-19 patients: A systematic review and meta-analysis. *Journal of Multimorbidity and Comorbidity*, 15, 26335565251371256. <https://doi.org/10.1177/26335565251371256>
- Pecly, I. M. D., et al. (2021). A review of COVID-19 and acute kidney injury: From pathophysiology to clinical results. *Brazilian Journal of Nephrology*, 43, 551–571.
- Portolés, J., et al. (2020). Chronic kidney disease and acute kidney injury in the COVID-19 Spanish outbreak. *Nephrology Dialysis Transplantation*, 35(8), 1353–1361. <https://doi.org/10.1093/ndt/gfaa189>
- Raharja, A. S., Arania, R., Utami, D., & Sinaga, F. T. Y. (2023). Hubungan antara reinfeksi COVID-19 pada pasien dewasa komorbid di RSUD Dr. H. Abdul Moeloek. *Jurnal Ilmu Kedokteran dan Kesehatan*, 10(7), 2453–2460.
- Salsabila, Z., Triyani, Y., & Achmad, S. (2023). Diabetes melitus sebagai komorbiditas utama terhadap mortalitas pasien COVID-19. *Jurnal Riset Kedokteran*, 109–116.
- Saputra, M., Dewi, P. H. W., Febriyanti, E. N., Ribeiro, P. C., Harpendani, P. A., & Noviana, A. C. (2022). Hubungan faktor risiko komorbid dengan tingkat kematian pasien COVID-19 di Puskesmas Manduro Kabupaten Mojokerto bulan Januari–Juni tahun 2021. *Jurnal CoMPHI: Jurnal Kedokteran Komunitas dan Kesehatan Masyarakat Indonesia*, 2(3), 83–88.
- Silaghi-Dumitrescu, R., Patrascu, I., Lehene, M., & Bercea, I. (2023). Penyakit penyerta pasien COVID-19. *Medicina*, 59(8), 1393. <https://doi.org/10.3390/medicina59081393>
- Vermonte, P., & Wicaksono, T. Y. (2020). Karakteristik dan persebaran COVID-19 di Indonesia: Temuan awal. *CSIS Commentaries*, 1, 1–12.
- Wang, X., et al. (2020). Comorbid chronic diseases and acute organ injuries are strongly correlated with disease severity and mortality among COVID-19 patients: A systematic review and meta-analysis. *Research*.
- Wishahi, M., & Kamal, N. M. (2022). Multidisciplinary basic and clinical research of acute kidney injury with COVID-19: Pathophysiology, mechanisms, incidence, management and kidney transplantation. *World Journal of Nephrology*, 11(3), 105–120.