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Association of pre-existing comorbidities and complications with inpatient COVID-19 mortality — a single-center retrospective study

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ABSTRACT

Background: *This study evaluates the impact of pre-existing comorbidities and in-hospital complications on COVID-19 mortality rates.*

Methods: *A retrospective single-center study was conducted using electronic health records from 640 COVID-19 patients hospitalized at the University Clinical Centre in Gdansk, Poland, between November 2020 and May 2021. Patients were categorized based on disease severity into stable or ICU wards based on the disease severity. Data on demographics, comorbidities, complications, and treatments were collected and verified. Statistical analyses, including odds ratios (ORs) and confidence intervals (CIs), assessed mortality risk factors supported by python-based processing.*

Results: *The mean patient age was 67 years (SD ± 15.89), comprising 39% females (n = 250) and 60.94% males (n = 390). Mortality risk was highest in patients aged 65 years and older (OR 3.00; 95% CI, 1.97–4.60). Among the pre-existing comorbidities, chronic kidney disease (OR 3.28; 95% CI, 2.12–5.09), atrial fibrillation (OR 2.43; CI 95%, 1.63–3.61), and heart failure (OR 2.89; 95% CI, 1.91–4.37) were significant predictors of mortality. In hospital complications, such as severe respiratory failure requiring ICU ventilation (OR 23.59; 95% CI, 2.81–197.87), myocardial infarction (OR 25.43; 95% CI, 3.16–204.97), acute kidney injury requiring renal replacement therapy (OR 19.15; 95% CI, 6.49–56.51), sepsis (OR 7.22, 95% CI, 3.77–13.84), stroke, further increased mortality risk.*

Conclusions: *COVID-19 patients with pre-existing renal and cardiovascular conditions face a higher risk of fatal outcomes. Early diagnosis and intervention targeting these complications are vital to in reducing mortality. Further research is needed to reconcile disparities with existing literature.*

Keywords: COVID-19 complications, SARS-CoV-2, comorbidity, in-hospital mortality, risk factors

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Introduction

The COVID-19 pandemic caused by SARS--CoV-2 has profoundly impacted global health, with over 695 million infections reported worldwide. Hospitalized patients experience severe complications such as multi-organ failure, often requiring intensive care. Risk factors consistently linked to severe outcomes include advanced age, male gender, and obesity, alongside pre-existing conditions such as diabetes, hypertension, cancer, stroke, and cardiovascular or pulmonary diseases [1–4].

Complications like sepsis, acute respiratory distress syndrome (ARDS), acute kidney injury (AKI), circulatory failure, thromboembolism, and coagulopathy considerably increase mortality risk, particularly among ICU patients who may require vasopressors or other critical interventions [5, 6].

This study aims to identify and examine the risk factors associated with COVID-19 mortality and severe disease progression among hospitalized patients in Central and Eastern Europe — an underrepresented population in current research. By addressing this gap, our findings seek to expand the existing knowledge base and inform strategies for better management of COVID-19 in this region.

Focusing on patients' unique challenges in Central and Eastern Europe, this research offers valuable insights for developing targeted interventions and healthcare policies tailored to the region's needs. These contributions are essential to improving outcomes and shaping a more effective response to the pandemic.

Methods

This single-center, retrospective study was conducted at the University Clinical Centre (UCC) in Gdansk, Poland, a multidisciplinary hospital providing comprehensive healthcare services. The study analyzed electronic health records (EHRs) of COVID-19 patients admitted to two specific wards — COVID-S "stable" and COVID-ICU — based on the severity of their condition between November 2, 2020, and May 25, 2021.

Wards and inclusion criteria

COVID-S ("stable") ward. Patients were admitted based on the following criteria:

1. Oxygen peripheral saturation (SpO2) < 95% requiring supplemental oxygen.
2. Dyspnea, severe cough, syncope, fatigue, or diarrhea with SpO2 ≥ 95%.
3. Complications of COVID-19 infection requiring hospitalization with SpO2 ≥ 95%.
4. Continued medical care for patients who tested positive for SARS-CoV-2 during hospitalization in another ward.

COVID-ICU ward. Patients requiring mechanical ventilation were admitted based on two out of the following three criteria, including criterion number 3:

1. Aggravation of respiratory failure despite non-invasive ventilation methods due to:
   - Persistently low SpO2 and partial pressure, leading to carbon dioxide retention and respiratory acidosis.
   - Intolerance to ventilation characterized by acute dyspnea, increased breathing effort, or anxiety with poor pharmacotherapy response.
2. Surgery, injury, or cardiopulmonary resuscitation requiring intubation.
3. Determination by an anesthesiologist that the patient required intensive care and could benefit from ICU hospitalization according to national guidance.

Study criteria

Inclusion criteria:

1. Minimum 18 years of age.
2. SARS-CoV-2 infection confirmed by a PCR test.
3. Hospitalization in a COVID-19 ward.

Exclusion criteria:

1. Incomplete data in the database.
2. Length of stay prolonged due to non-medical issues, such as administrative and socioeconomic.
3. Admission to the COVID-19 ward for medical procedures (e.g., radiotherapy, chemotherapy) that could not be conducted in other wards due to public health hazards.

This study was conducted with the approval of the Ethics Committee of the Medical University of Gdansk (NKBBN/327/2022). The informed consent was waived due to the retrospective nature of the study.

Statistical analysis

This study aimed to identify factors associated with COVID-19 mortality using odds ratio (OR) to measure the strength of association between specific risk factors and outcome, such as mortality, estimating relative rather than absolute risk. Confidence intervals (CIs) assessed the reliability of these estimates, with narrower intervals indicating higher precision. A 95% CI was typically used,

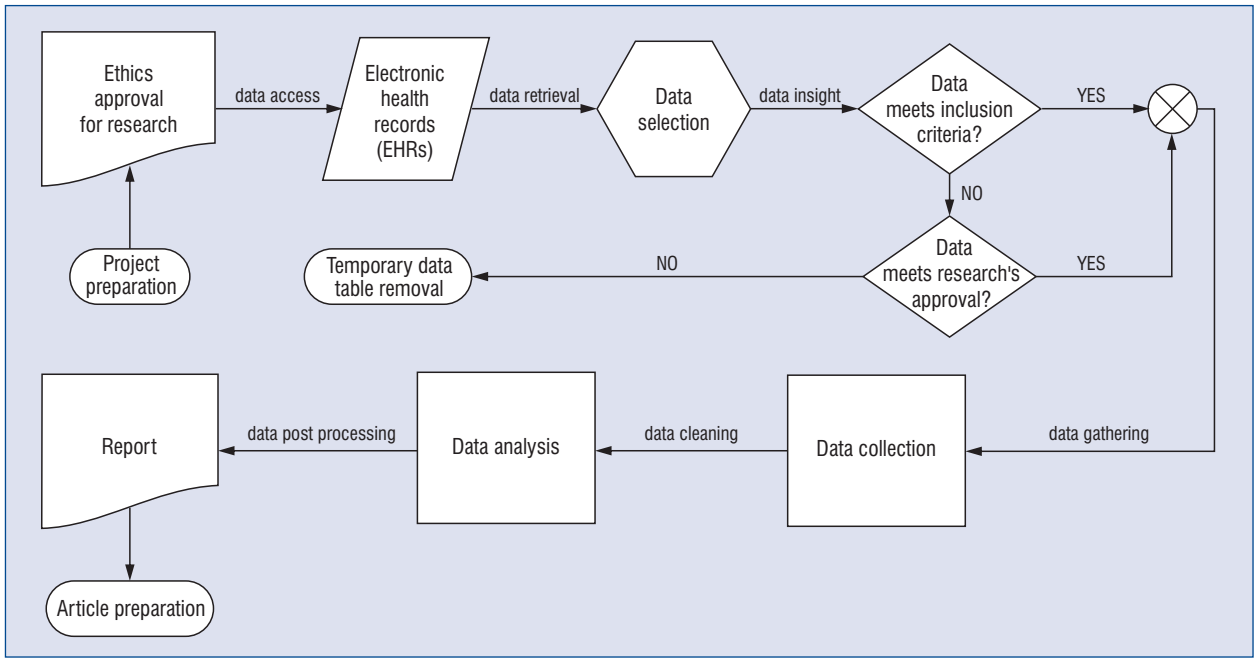

Figure 1. Detailed workflow for Analyzing Mortality Risks

narrowing as the sample size increased. Haldane--Anscombe correction was applied for zero-value cells. T-tests were conducted to compare survivors and non-survivors, and P-values were calculated to determine statistical significance.

Data collection

Researchers collected data from EHRs, including:

1. Demographics: gender, age, body mass index (BMI).
2. Comorbidities: cardiovascular, neurological, pulmonary, neoplasms, transplantations.
3. Complications: health issues during COVID-19 infection.
4. Treatments: administered medical interventions.

Data collection spanned from July 2022 to September 2023. Three researchers independently verified 10% of the entries to ensure accuracy and resolved discrepancies collaboratively. Figure 1 illustrates the steps of the research process.

We compiled a database of 640 patients meeting the inclusion criteria, resulting in 348 distinct treatment sets. This dataset included demographic and clinical data covering 179 comorbid conditions and 133 cardiovascular comorbidities. Key factors linked to mortality risks, such as comorbidities, therapies, complications, and transplantations, were analyzed for their impact on outcomes.

Patients were categorized into exposed and unexposed groups based on the presence of specific factors. Using one-hot encoding, binary values (1 or 0) were assigned to each factor, simplifying data structure and enabling statistical comparisons. Statistical tests, such as T-tests, ensured group differences were not random. Mortality risks were assessed using odds ratios (ORs), a standard tool in case-control studies, comparing survivors and non-survivors to calculate risk factors. ORs were complemented by confidence intervals (CIs) to quantify uncertainty. The OR formula and its standard error (SE) were applied to determine the significance of associations guiding inferences about population-level mortality risks.

The OR formula is described here and also the calculation of CIs is presented below.

OR — (c/d)(a/b)

a — sum of non-survivors with the factor

b — sum of survivors with the factor

c — sum of non-survivors without the factor

d — sum of survivors without the factor

SE ln(OR) — sqrt(1/a + 1/b + 1/c + 1/d)

The 95% statistical significance for the confidence interval (CI) and the ln(OR) is calculated as ln(OR with 95% significance) = ln(OR) ± 1.96 × {SE ln(OR)}.

Confidence intervals (CIs) were calculated to quantify uncertainty in the odds ratio (OR) estimates. Higher ORs indicated stronger effects,

Table 1. Demographic data of patients in the study population

		Survivors, n		Total, n	Non-survivors, n		Total, n
Sex		**Female**	**Male**		**Female**	**Male**	
		184	297	481	66	93	159
Body Mass Index	< 18,5	6	10	16	3	2	5
	18,5–24,9	48	65	113	14	20	34
	25–29,9	55	109	164	21	38	59
	30–34,9	31	68	99	17	16	33
	> 35	29	28	57	2	1	3
Mean age (years)		67,4	63		75,2	73	

For the sake of readability, the data are presented in the following tables: count of cases (a + b) and count of death cases having the factor (a). Transformation to a 2 × 2 contingency table for data verification can be done with simple algorithmic steps (a + b) – a = b, all non-survival cases: 159 – a = c, all survival cases: 481 – b = d

while wider CIs suggested weaker associations or smaller sample sizes. Since ORs are not normally distributed, logarithmic transformations were used to calculate asymmetric CIs, with significance determined *via* a z-test at a 5% level. Comparing ORs and CIs across factors provided insights into their relative mortality risks. Factors with CI ranges above one increased mortality risk, while those below 1 decreased it. Data processing and calculations were conducted using Python libraries such as *pandas*, *scipy, numpy*, and *statsmodels*.

Results

Demographic and biometric data

A database consisting of 640 patients was analyzed. The average age of all patients was 67 years (SD ± 15.89), with survivors averaging 64.7 years and non-survivors averaging 74 years. The median age was 69 years overall, with survivors having a median age of 67 years and non-survivors 75 years. Female patients constituted 39% of the cohort (n = 250), with an average age of 69.5 years (67.4 for survivors and 75.2 for non-survivors). Male patients averaged 65.5 years (63 for survivors and 73 for non-survivors).

Body Mass Index (BMI) followed by the World Health Organization (WHO): overweight (BMI 25.0–29), Obesity Class I (BMI of 30.0–34.9), Obesity Class II (BMI of 35.0–39.9), and Obesity Class III (BMI ≥ 40.0). Due to the limited number of individuals with Class II and Class III obesity, individuals were grouped with a BMI > 35 together.

The overall mortality rate was 24.84% (n = 159). The mortality rate in the S-COVID ward was 23.23% (n = 101), whereas the COVID-ICU ward showed a higher mortality rate of 75.86% (n = 58). Demographic data is shown in Table 1. Advanced age significantly increased the risk of death. Patients were categorized into three age groups: young-old (≤ 64 years), middle-old (65–84 years), and oldest-old (≥ 85 years). Mortality was significantly lower in the younger group than in the older groups (p-value < 0.0001). Additionally, survival rates did not differ significantly by sex.

Odds ratio (OR) analysis revealed that patients aged 65 and above had the highest mortality risk (OR of 3.01). Geriatric patients aged 85 and over had an OR of 3.47. In contrast, patients aged below 64 had a lower risk of death (OR 0.32). Table 2 summarizes OR statistics and corresponding CIs for the population, all maintained at a 5% level of statistical significance.

Contrary to expectations, high BMI (> 35) was not associated with higher mortality; instead, a decreased risk was observed in this subgroup.

Comorbidities

Findings indicated that pre-existing conditions such as chronic kidney disease (CKD) and diabetes mellitus (DM) were significant mortality risk factors, with ORs of 3.28 and 1.74, respectively. Similarly, cancer and neurological diseases also posed increased risks, with ORs of 1.68 and 1.66, respectively.

Dementia, heart failure, and atrial fibrillation (AF) further elevated mortality risk with ORs of 3.00, 2.89, and 2.43, respectively. These findings are summarized in Table 3.

Complications

Cardiovascular and renal complications significantly increased the risk of mortality. Acute

Table 2. Demographic and biometric factors associated with mortality risk in COVID-19 among the study population — summary of OR statistics

Group		All in group (a + b)	Non-survivors with factor (a)	Survivors with factor (b)	Non-survivors without factor (c)	Survivors without factor (d)	OR	CI
Age (years)	< 18	0	n/a	n/a	n/a	n/a	n/a	n/a
	18–34	28	2	26	157	455	0.22***	0.05–0.95
	35–49	71	5	66	154	415	0.20***	0.08–0.52
	50–65	146	26	120	133	361	0.59	0.37–0.94
	> 65	395	126	269	33	212	3.01***	1.97–4.59
Elderly (> 64)	Aged 64 years and under	228	29	199	130	282	0.32***	0.20–0.49
	Aged 65 to 84 years	343	96	247	63	234	1.44*	1.00–2.08
	Aged 85 years and over	69	34	35	125	446	3.47***	2.08–5.78
Sex	Female	250	66	184	93	297	1.15	0.79–1.65
	Male	390	93	297	66	184	0.87	0.61–1.26
	< 18.5	21	5	16	154	465	0.94	0.34–2.62
	18.5–24,9	147	34	113	125	368	0.89	0.57–1.38
BMI	25–29,9	223	59	164	100	317	1.14	0.78–1.66
	30–34,9	132	33	99	128	382	1.01	0.65–1.57
	> 35	60	3	57	156	424	0.14*	0.04–0.46

*p < 0.05, **p < 0.01, ***p < 0.001

myocardial infarction (MI) (OR 25.43) and acute kidney injury (AKI) that necessitated renal replacement therapy (RRT; OR 19.15) posed the highest risk. Other significant complications included acute stroke (OR 7.77), sepsis (7.22), circulatory failure requiring vasopressors (OR 6.18), and pulmonary embolism (OR 2.07; Tab. 4).

Underlying conditions and applied treatment

This study did not evaluate specific treatment as an independent risk factor but analyzed underlying conditions that necessitated treatment. Patients requiring oxygen therapy faced increased mortality risks: CPAP therapy (OR 9.07) and HFNO therapy (OR 3.94). Corticosteroid therapy introduced during oxygen therapy was associated with higher mortality (OR 2.01). ICU ventilator use resulted in the highest mortality risk (OR 23.59). Antibiotic polytherapy due to bacterial infections also correlated with higher mortality (OR 2.42) compared to monotherapy with piperacillin/tazobactam (OR 2.13) or other antibiotics (OR 1.46). Interestingly, monotherapy with ceftriaxone was not associated with increased mortality. Surprisingly, convalescent plasma transfusion significantly reduced mortality (OR 0.61). Preexisting anticoagulation was associated with increased mortality (OR 1.69), whereas prophylactic heparin and remdesivir showed no significant effects.

Discussion

Demographics

Advanced age emerged as a critical mortality risk factor in the present study, consistent with the existing literature showing increased mortality among the older population [7]. Age-related physiological decline, comorbid conditions, and immune system alterations likely contributed to this trend. Stratification by age underscores the need for targeted interventions and resource allocation to protect the most vulnerable groups.

Interestingly, there was no suggestive evidence that male gender independently increases the risk of death from COVID-19. While some studies report higher mortality in men, others suggest these differences are linked to underlying health conditions and behavioral factors rather than gender itself. Early pandemic reports

Table 3. Odds ratio of comorbidities in COVID-19 patients

Group		All in group (a + b)	Non-survivors with factor (a)	Survivors with factor (b)	Non-survivors without factor (c)	Survivors without factor (d)	OR	CI
Cardiovascular		470	126	344	33	137	1.52	0.99–2.34
	Atherosclero-sis	52	14	38	145	443	1.13	0.59–2.14
	Hypertension	372	92	280	67	201	0.99	0.69–1.42
	Coronary artery disease	131	38	93	121	388	1.31	0.85–2.01
	Heart failure	124	53	71	106	410	2.89***	1.91–4.37
	Atrial fibrillation	147	57	90	102	391	2.43***	1.63–3.61
	Venous thrombo-emb-olism	42	12	30	147	451	1.23	0.61–2.46
	Valvular heart dis-ease	37	11	26	148	455	1.30	0.63–2.69
	History of myocar-dial infarction	9	3	6	156	475	1.52	0.38–6.16
Diabetes		191	62	129	97	352	1.74**	1.19–2.54
Chronic kid-ney disease		104	48	56	111	425	3.28***	2.12–5.09
Chronic pulmonary disease		88	28	60	131	421	1.50	0.92–2.45
	Chronic obstructive pulmonary disease	49	17	32	142	449	1.68	0.91–3.12
	Asthma	30	7	23	152	458	0.92	0.39–2.18
Cancer (incl. hematologic cancers)		257	79	178	80	303	1.68**	1.17–2.41
	In medical history	7	2	5	157	476	1.21	0.23–6.31
	Active (favorable prognosis)	3	0	3	159	478	0.50	0.02–10.06
	Active (unfavorable prognosis)	8	2	6	157	475	1.01	0.20–5.05
Neurological disease		144	47	97	112	384	1.66*	1.11–2.49
	Dementia	29	14	15	145	466	3.00**	1.41–6.36
	Stroke in medical history	52	13	39	146	442	1.01	0.52–1.94
	Paresis and paraly-sis	24	6	18	153	463	1.00	0.39–2.59
	History of stroke	25	9	16	150	465	1.74	0.75–4.03
Smoking		198	41	157	118	324	0.72	0.47–1.07
Transplant		22	8	14	151	467	1.77	0.73–4.29
	Kidney	14	5	9	154	472	1.70	0.56–5.16
	Liver	2/1	1	1	158	480	3.04	0.19–48.86
	Heart	3	0	3	159	478	0.50	0.02–10.06
	Lung	3	2	1	157	489	6.11	0.55–67.99

*p < 0.05, **p < 0.01, ***p < 0.001

Table 4. Complications that occurred during hospitalization in COVID-19 patients

Complication	All in group (a + b)	Non-survivors with factor (a)	Survivors with factor (b)	Non-survivors without factor (c)	Survivors without factor (d)	OR	CI
Pulmonary embolism	38	15	23	144	458	2.07*	1.05–4.08
Acute myocardial infarction	9	8	1	151	480	25.43***	3.15–204.97
Acute stroke	7	5	2	154	479	7.77**	1.49–40.48
Sepsis	45	30	15	129	466	7.22***	3.77–13.83
Acute circulatory failure	6	4	2	155	479	6.18*	1.21–34.07
Acute kidney injury	26	22	4	137	477	19.15***	6.49–56.51
Bacterial pneumonia	6	3	3	156	478	3.06	0.61–15.34

*p < 0.05, **p < 0.01, ***p < 0.001

Table 5. The applied course of treatment linked with mortality in COVID-19 patients

Group		All in group (a + b)	Non-survivors with factor (a)	Survivors with factor (b)	Non-survivors without factor (c)	Survivors without factor (d)	OR	CI
Antibiotics — monotherapy	Ceftriaxone	192	55	137	104	344	1.33	0.91–1.95
	Piperacillin/tazobactam	129	48	81	111	400	2.13***	1.41–3.23
	Other	231	68	163	91	318	1.46*	1.01–2.10
Antibiotics — polytherapy		282	96	186	63	295	2.42***	1.67–3.49
Need for oxygen therapy	CPAP	45	32	13	127	468	9.07***	4.62–17.79
	HFNO	35	19	16	140	465	3.94***	1.98–7.87
	ICU ventilator	7	6	1	118	464	23.59***	2.89–197.87
Unfractionated heparin		576	139	437	20	44	0.70	0.39–1.23
Long-term anticoagulant therapy		190	61	129	98	352	1.69**	1.16–2.47
Convalescent plasma		153	28	125	131	356	0.61*	0.39–0.96
Remdesivir		141	28	113	131	368	0.69	0.44–1.10
Corticosteroids		478	133	345	26	136	2.01**	1.27–3.21

*p < 0.05, **p < 0.01, ***p < 0.001

indicated higher male mortality, but later studies pointed to comorbidities and lifestyle factors as more influential [8].

The lack of association between high BMI (≥ 35) and mortality was an unexpected finding, diverging from most studies linking obesity to worse COVID-19. However, a 2022 meta-analysis of over three million individuals strongly associated obesity with severe COVID-19 outcomes and death [9]. These discrepancies warrant further investigation to explore potential biases, cohort differences, or other confounding factors.

Comorbidities

COVID-19 patients face increased mortality risks from certain cardiovascular diseases, though comparisons between medical centers are challenging due to varying definitions. The current study found that heart failure, atrial fibrillation (AF), and anticoagulant treatment elevated mortality risk, while coronary artery disease, valvular heart disease, and hypertension did not. Although hypertension was initially suggested as a significant factor, studies like Mirza et al. and Guan et al. demonstrated it is not an independent mortality risk when broader clinical factors and multiple risk factors are considered [10, 11].

Diabetes mellitus (DM) significantly increased mortality risk, as supported by prior research [12]. Kania et al. confirmed this in the Polish population, particularly for patients aged 60–69 [13]. Chronic kidney disease (CKD) was a strong independent risk factor, with an odds ratio of 3.28 (95% CI, 2.12–5.09), consistent with prior findings [14]. However, the roles of glomerular filtration rate and albuminuria in CKD progression and mortality remain unclear [15].

Interestingly, chronic pulmonary disease, including COPD, were not associated with increased mortality. A meta-analysis of 39 studies showed a higher risk of death for individuals with COPD than for those without it [16]. Other literature emphasizes the link between COPD and the severe course of COVID-19 but not increased mortality [17]. Differences in baseline pulmonary function, treatment modalities, and population characteristics may explain this inconsistency and suggests a need for further research to clarify the specific impact of these conditions on COVID-19 outcomes.

Cancer-related mortality risk was complex, with metastatic solid tumors and hematologic malignancies increasing risk, as shown by Chavez-MacGregor et al. While the present cancer group showed higher mortality overall, subgroup analysis did not pinpoint a specific type of cancer as independently contributing to risk, reflecting the diversity of cancer biology and treatments [18].

Transplant recipients also faced varied risks. Solid organ transplant recipients (SOTr) had higher mortality, with lung transplant recipients most affected and liver transplant recipients showing the lowest risk [19, 20]. Hematopoietic stem cell transplant (HSCT) recipients had elevated risks for complications and death. However, the current study observed no increased mortality in transplant recipients, likely due to the small cohort size [21].

Complications

Early complications in COVID-19 are significant predictors of mortality, particularly thromboembolic events such as myocardial infarction (MI), ischemic stroke, and pulmonary embolism [22]. Early initiation of thromboprophylaxis has been shown to reduce 30-day mortality without substantially increasing the risk of severe bleeding risk, underscoring the critical importance of timely recognition and management of these complications [23].

The onset of kidney complications during COVID-19 infection, particularly AKI, and the subsequent need for RRT further amplifies the risk of mortality [24]. The present study validates RRT as one of the primary independent risk factors for mortality during COVID-19, with an odds ratio of 19.15 (95% CI, 6.49–56.51). AKI is a well-documented renal complication that poses a significant risk for mortality [25]. Therefore, we emphasize the importance of monitoring kidney function during COVID-19 infections, as kidney dysfunctions may serve as a prognostic indicator for the severity and mortality of COVID-19.

Bacterial infections, particularly respiratory tract infections and sepsis, present additional challenges in managing COVID-19 patients. Diagnostic complexities further complicate these cases. Sepsis, defined per the Sepsis-3 criteria as life-threatening organ dysfunction with a SOFA score increase of ≥ 2, increases death risk by 7.22 times (95% CI: 1.12–34.07) [26]. Bacterial co-infections or secondary infections are frequent among critically ill COVID-19 patients, significantly contributing to adverse outcomes. Previous studies have consistently highlighted the critical role of secondary bacterial infections in COVID-19 mortality [27].

Course of treatment

The treatments analyzed in this study should not be interpreted as causative factors for increased mortality risk in COVID-19 patients but rather as reflective of the severity of underlying conditions and complications. Respiratory failure, a common complication, is strongly associated with mortality risk, with severity directly influencing outcomes. Limited data exist on the specific mortality impact of CPAP or HFNO; however, ARDS and mechanical ventilation are well-established predictors of poor prognosis [28].

The current findings demonstrate that patients with severe respiratory failure face elevated mortality. The OR for mortality was 3.9 (95% CI, 1.98–7.87) for patients on HFNO, 9.0 (95% CI, 4.62–17.79) for

those on CPAP, and 23.59 (95% CI, 2.81–197.87) for patients requiring mechanical ventilation. A study by Marti et al. revealed that using HFNO or CPAP reduces the need for intubation and mortality risk compared to non-invasive ventilation (NIV) [29]. Nevertheless, research findings herein confirm that patients receiving CPAP or HFNO therapy require intensive monitoring due to their heightened risk.

Patients treated with a single antibiotic for bacterial infections exhibited a 1.46 times higher risk of death (95% CI, 1.01–2.1), while those needing two or more antibiotics have a 2.4-fold higher risk (95% CI, 1.67–3.49). These findings align with existing literature [27]. Timely identification of concurrent bacterial infections and the appropriate administration of antibiotics can help reduce mortality during COVID-19.

Study limitations

This single-center study, conducted with a multidisciplinary framework, included a diverse patient population encompassing specialized departments like transplantology, oncology, and cardiology. Many COVID-19 patients presented with severe comorbidities, enabling us to analyze rare factors, such as the impact of organ transplantation and cancer on mortality.

However, the single-center design limits the generalizability of these findings. Additionally, a small sample size for specific subgroups, such as transplant recipients, restricts the robustness of subgroup analyses. Potential unmeasured confounders and missing data could also have influenced the results.

Conclusion

The present study identifies advanced age, cardiovascular comorbidities, and chronic kidney disease as the most critical risk factors for mortality in COVID-19 patients. Furthermore, complications such as cardiovascular renal dysfunction requiring Renal Replacement Therapy, along with respiratory failure necessitating high-flow oxygen therapy or mechanical ventilation, substantially increase the risk of mortality. Cancer, diabetes, and neurological diseases played a comparatively lesser role.

Certain findings, such as the lack of an observed link between obesity and mortality, diverge from existing literature, highlighting the need for further research to validate and contextualize these results. Additionally, studies will be essential for reconciling these discrepancies with broader scientific knowledge and providing deeper insights into COVID-19 mortality risk factors. A comprehensive understanding of these predictors can ultimately inform improved screening, early detection, and treatment strategies, reducing mortality rates among COVID-19 patients.

Data availability statement: Data availability: Raw data from electronic health records generated at the University Clinical Centre in Gdansk, Poland, are not publicly available to preserve individuals' privacy under the European General Data Protection Regulation. Derived data is available at a reasonable request from the corresponding author.

Ethics statement: Ethics approval: This study was performed under the principles of the Declaration of Helsinki. The Medical University of Gdansk Ethics Committee granted approval, with the ethics approval number NKBBN/327/2022 consent to participate. This research study was conducted retrospectively using de-identified data obtained for clinical purposes. The Medical University of Gdansk Research Ethics Committee confirmed that formal consent was unnecessary.

Authors contribution: TS and KK conceived and designed the analysis and supervised the project. DP, OP-D and MG collected the data. DP wrote the manuscript. MG translated and reviewed the manuscript. MH, DK and RO revised the manuscript. KG provided statistical analysis.

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