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# Factors Associated with Mortality Among Hospitalized Adults with COVID-19 Pneumonia at a Private Tertiary Hospital in Tanzania: A Retrospective Cohort Study

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**Background:** The emergence of the novel coronavirus disease 2019 (COVID-19) has caused millions of deaths worldwide. There has been paucity of data for hospitalized African patients suffering from COVID-19. This study aimed to identify factors associated with in-hospital mortality in patients suffering from COVID-19 in Tanzania.

**Methods:** This was a single center, retrospective, observational cohort study in adult patients hospitalized with confirmed COVID-19 infection. Demographics, clinical pattern, laboratory and radiological investigations associated with increased odds of mortality were analyzed.

**Results:** Of the 157 patients, 107 (68.1%) patients survived and 50 (31.8%) died. Mortality was highest in patients suffering with severe (26%) and critical (68%) forms of the disease. The median age of the cohort was 52 years (IQR 42–61), majority of patients were male (86%) and of African origin (46%), who presented with fever (69%), cough (62%) and difficulty in breathing (43%). Factors that were associated with mortality among our cohort were advanced age (OR 1.07, 95% CI 1.03–1.11), being overweight and obese (OR 9.44, 95% CI 2.71–41.0), suffering with severe form of the disease (OR 4.77, 95% CI 1.18–25.0) and being admitted to the HDU and ICU (OR 6.68, 95% CI 2.06–24.6).

**Conclusion:** The overall in-hospital mortality was 31.8%. Older age, obesity, the severe form of the disease and admission to the ICU and HDU were major risk factors associated with in-hospital mortality.

**Keywords:** COVID-19, factors, hospital, mortality, Tanzania

## Introduction

Coronavirus disease 2019 (COVID-19) caused by SARS-CoV-2 first emerged in Hubei Province, China in December 2019. Since then, not only has COVID-19 been considered a health emergency of international concern<sup>1</sup> but it has also been declared a global pandemic.<sup>1</sup> As of 9th July, 2021, the World Health Organization (WHO) officially confirmed over 185 million cases of COVID-19 globally with 4 million deaths. Tanzania reported its first case on 16th March 2020.<sup>2</sup> Even though most African countries have a fragile health system, the Case Fatality Rate (CFR) for COVID-19 in Africa is surprisingly lower than the global trend.<sup>3</sup> Low testing rates, a younger population, humid temperatures and possibility of a preexisting immunity are some of the postulated factors associated with this difference.<sup>3</sup>

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Although the SARS-CoV-2 virus predominantly targets the respiratory system,<sup>4</sup> its associated mortality involves multiple organ systems.<sup>4</sup> An increasing understanding of the disease over the course of the pandemic has led to reduction in in-hospital mortality rates, especially in well-resourced and high-income countries.<sup>5–7</sup> In contrast, in-hospital mortality remains comparatively high in Africa. This has been attributed to the burden of underlying comorbidities and resource deficits.<sup>8</sup> Reports globally have indicated that increasing age,<sup>9–11</sup> comorbidities (cardiovascular disease, diabetes)<sup>9,12,13</sup> and obesity<sup>14,15</sup> are all associated with adverse outcomes. In addition, certain demographic characteristics<sup>10–12,16</sup> and laboratory parameters<sup>17–19</sup> have also been associated with the severe form of COVID-19 and increased mortality.

In Tanzania, the population characteristics skew towards the younger age range and a lower life expectancy compared to higher-income countries. Despite the alarming growing numbers of non-communicable diseases (NCD),<sup>20</sup> communicable diseases such as human immunodeficiency virus (HIV), tuberculosis, malaria and other neglected infectious diseases are still highly prevalent in the population. The objective of the present study was to describe clinical features and identify risk factors associated with mortality among patients hospitalized with COVID-19 in Tanzania.

## Methodology

### Study Design and Participants

This was a retrospective cohort study of adults aged 18 years and above admitted to the COVID-19 isolation unit between 29th March and 31st July 2020. We enrolled eligible patients that were hospitalized with confirmed COVID-19 via a positive SARS-CoV-2 RT-PCR and had a final outcome (either death or discharge). The criteria for discharge was maintenance of oxygen saturation at rest or above 94% on room air, respiratory rate less than 24 breaths/min and absence of fevers over a 24-hour period.

### Study Location

The study was conducted at the COVID-19 isolation unit of the Aga Khan Hospital, Dar es Salaam, Tanzania. The Aga Khan Hospital, Dar es Salaam is the only Joint Commission International (JCI) accredited hospital in the country. The COVID-19 isolation unit is housed in a building separate from other patients and comprises the general isolation ward and the COVID-19 Critical Care

Unit (CCU). The CCU is split into the intensive care unit (ICU) and the high dependency unit (HDU). The general isolation ward consisted of two separate wards (one for suspect cases and one for confirmed positive PCR patients) located on two separate floors with 25 beds each. The COVID-19 CCU has an eight-bed ICU and twelve-bed HDU. The suspect and confirmed isolation ward is overseen by a clinical team that is composed of specialists from the department of internal medicine, paediatrics, as well as residents, medical officers, and interns. Both the HDU and ICU are managed by a multidisciplinary team, which includes a full-time critical care specialist, primary physician, internal medicine resident, medical officer, physiotherapist and dietician. The ICU is able to provide both invasive and non-invasive mechanical ventilation, invasive hemodynamic monitoring, and inotropic support. The HDU serves as a step-down unit for the ICU and houses patients who are critically ill requiring high-flow oxygen. Patients requiring hemodialysis are transferred to a separate designated dialysis unit within the isolation unit. The ICU and HDU have round-the-clock coverage with an anesthesiologist and a team of medical officers from various specialties such as internal medicine, anesthesia, and emergency medicine. The nurse-to-patient ratio for ICU and HDU was 1:1 and 1:4, respectively.

### Data Collection

We obtained medical records and compiled data for adult patients aged 18 years and above with laboratory confirmed COVID-19 as tested by the National Public Health Laboratory, between 29th March and 31st July 2020. The admission register was used to identify patients; their files both electronic and paper-based were retrieved from medical records. Patient demographics, clinical and laboratory data as well as radiological findings and outcomes were obtained. Data were collected by research assistants who had experience working in the COVID-19 isolation unit. Extracted data were independently verified by the primary investigator for accuracy and completeness. We categorized race into three main categories: African, South Asians (Indians and Pakistanis) and Chinese. The rest were grouped under “Others”. Patients’ initial radiographs, done on admission to the hospital, were classified broadly into four main groups: local patchy shadowing, bilateral patchy shadowing, interstitial abnormalities and ground glass opacification. Patient’s clinical status<sup>21</sup> and Body Mass Index (BMI) were classified according to WHO classification.<sup>22</sup>

## Laboratory Procedures and Treatment Protocol

Nasal and oropharyngeal swab samples for patients admitted were collected by trained laboratory technicians and placed in sterile viral transport media tubes. These were delivered to the National Public Health Laboratory (NPHL) strictly following government and WHO protocols for collection, storage and transport. At NHPL, the samples were tested for SARS-CoV-2 using reverse transcription-polymerase chain reaction (RT-PCR). Results were mailed back to the hospital through a central and local public health body reporting mechanism. A confirmed case of COVID-19 was defined as positive on RT-PCR assay of nasal and oropharyngeal swab specimens.

The standard institutional guideline for COVID-19 patients was divided into two: (i) general management and (ii) COVID-19 specific therapy. General management included the guidance on the use of empiric treatment (intravenous (IV) Ceftriaxone 1000 mg twice daily or IV Piperacillin-Tazobactam 4500 mg thrice daily) for bacterial co-infection, prevention and therapy of venous thromboembolism for all hospitalized patients, the use of IV paracetamol for fever, treatment of underlying conditions, protocols for chest physiotherapy, nutritional guidance and a note to avoid forms of medication given by nebulization to prevent aerosolization of viral particles. At the time of this study, the only COVID-19 specific therapy used was daily systemic corticosteroids either intravenous Dexamethasone 6 mg IV once daily or oral Prednisolone 0.5mg/kg/day in two divided doses, but this was limited to those who required oxygen or who were critically ill. We encouraged all oxygen-dependent hospitalized patients to spend as much time as practical and safe in prone position. For patients requiring oxygen supplementation, we followed recommendations from WHO which suggested titrating oxygen to target peripheral oxygen saturation (SpO<sub>2</sub>) of  $\geq 94\%$  with the lowest fraction of inspired oxygen (FiO<sub>2</sub>). The decision to intubate was multifactorial and was dependent on clinical and gas exchange parameters.

## Statistical Analysis

Demographic data were summarized using frequency tables and percentages, while continuous and categorical variables were presented as median (IQR) and n (%), respectively. A chi-square test/Fisher's exact test was used to identify the presence of a statistical significant difference between survivors and non-survivors.

Statistical significant difference was set at a p-value of  $<0.05$ . To identify factors associated with mortality in hospitalized COVID-19 disease, logistic regression model was used. Variables significantly associated with disease severity at 5% level of significance in the univariate analysis were considered in the multivariable model. In the final model, adjusted odds ratio (OR), p-value and 95% CI for OR were used to test significance and interpretation of results. Variables with p-value  $\leq 0.05$  were considered as major risk factors associated with mortality. All analyses were performed using STATA software version 15 (College Station, TX).

## Results

During the study period; 157 patients who tested positive for SARS-CoV-2 were included in the analysis of the study, out of which 107 (68.2%) survived, while 50 (31.8%) died. [Table 1](#) shows general and clinical characteristics of the cohort and provides a comparison of survivors to non-survivors. The median age of the cohort was 52 years (IQR 42–61). The majority of the population were male (86%) and of African origin (46%). More than one comorbid condition per critically ill patient was recorded when present. The most common comorbid condition amongst our cohort was diabetes mellitus (11%) and hypertension (7.6%). Most notably two-thirds of the cohort population was either overweight (30%) or obese (37%). The overall median length of stay was 6 days (IQR 3–10). Higher percentage of mortality with statistical significance ( $P < 0.05$ ) was noted amongst males (78%), aged between 45 and 64 years (44%), those who were suffering from both diabetes mellitus as well as hypertension (30%) and those who were obese (62%).

Majority of our patients were symptomatic; the most common symptoms on admission were fever (69%), cough (62%) and difficulty in breathing (43%) as shown in [Table 2](#). Vitals on admission were evaluated; the overall median respiratory and pulse rates were 24 breaths/min (IQR 20–30) and 98 beats/min (IQR 85–110), respectively. When survivors and non-survivors were compared, a higher percentage of mortality with statistical significance ( $P < 0.05$ ) was noted in those who presented with difficulty in breathing (54%). Additionally, a higher respiratory rate of 28 breaths/min (IQR 24–33) and pulse rate of 104 beats/min (IQR 90–120) was noted amongst non-survivors ( $P < 0.05$ ). No statistically significant difference was noted when systolic and diastolic blood

**Table 1** Demographic and Clinical Characteristics of Patients

Variable	N	Overall, N = 157 <sup>a</sup>	Patient Outcome		p-value <sup>b</sup>
			Survivor, N = 107 <sup>a</sup>	Non-Survivors, N = 50 <sup>a</sup>	
Age	157	52 (42–61)	48 (37–57)	60 (49–69)	<0.001
< 45		52 (33%)	44 (41%)	8 (16%)	
45–64		71 (45%)	49 (46%)	22 (44%)	
65–74		27 (17%)	11 (10%)	16 (32%)	
>75		7 (4.5%)	3 (2.8%)	4 (8.0%)	
Sex	157				0.049
Female		22 (14%)	11 (10%)	11 (22%)	
Male		135 (86%)	96 (90%)	39 (78%)	
Race	157				<0.001
African		72 (46%)	45 (42%)	27 (54%)	
South Asians		53 (34%)	32 (30%)	21 (42%)	
Chinese		9 (5%)	9 (8.4%)	0 (0%)	
Others		23 (15%)	21 (9.6%)	2 (4.0%)	
Comorbid	157				
None		62 (39%)	58 (54%)	4 (8.0%)	< 0.0001
DM		18 (11%)	15 (14%)	3 (6.0%)	0.1418
HTN		12 (7.6%)	9 (8.4%)	3 (6.0%)	0.5963
HIV		4 (2.5%)	1 (0.9%)	3 (6.0%)	0.0606
Asthma or COPD		9 (5.7%)	3 (2.8%)	6 (12%)	0.0209
DM & HTN		29 (18%)	14 (13%)	15 (30%)	0.0109
DM, HTN, and CKD		9 (5.7%)	6 (5.6%)	3 (6.0%)	0.9215
DM, HTN, and CAD		4 (2.5%)	0 (0%)	4 (8.0%)	0.0030
Others		10 (6.4%)	1 (0.9%)	9 (18%)	< 0.0001
BMI	134				<0.001
Healthy weight		44 (33%)	39 (45%)	5 (10%)	
Overweight		40 (30%)	27 (31%)	13 (27%)	
Obese		50 (37%)	20 (23%)	30 (62%)	
LOS (Days)		6 (3-10)	6 (4-11)	3 (1-7)	<0.001

**Notes:** <sup>a</sup>Median (IQR) or frequency (%) <sup>b</sup>Wilcoxon rank sum test; Fisher's exact test; Pearson's Chi-squared test.

**Abbreviations:** DM, diabetes mellitus; HTN, hypertension; CKD, chronic kidney disease; CAD, coronary artery disease; COPD, chronic obstructive pulmonary disease; BMI, body mass index; LOS, length of stay; <, less than; >, more than.

pressures were compared amongst survivors and non-survivors.

More than half (67%) patients required oxygen supplementation on admission as seen in Table 3 either via nasal prongs (16%), face mask (7.6%) or non-rebreather mask (39%). Six patients (3.8%) were intubated at accident's and emergency department prior to admission, of which five did not make it to hospital discharge. Normal chest X-ray on admission was only noted amongst 20 patients (15%), with the majority having radiological features suggestive of bilateral patchy shadowing (34%) or ground glass opacities (24%). The bulk of the admissions was patients suffering from the severe (39%) and critical (29%) form of the disease. When survivors and non-survivors were

compared, higher mortality rates were noted in those who required oxygen support via non-rebreather mask (66%), suffering with critical illness (68%) and those who required intensive care (40%).

Table 4, below illustrates initial laboratory parameters of our study population and provides a comparison of survivors to non-survivors. We observed a statistically significant difference ( $P < 0.05$ ) in initial laboratory findings between survivors and non-survivors. Non-survivors had a significantly higher median leukocyte count  $10.4 \times 10^9/L$  (IQR 6.3–14.9), absolute neutrophil count  $8.3 \times 10^9/L$  (IQR 5.0–13.9) and an elevated C-reactive protein (CRP) 207 mg/L (IQR 90–301). Likewise, higher levels of serum Lactate Dehydrogenase (LDH) 504 IU/L (IQR 412–728),

**Table 2** Presenting Symptoms and Initial Vitals on Admission

Variable	N	Overall, N = 157 <sup>a</sup>	Patient Outcome		p-value <sup>b</sup>
			Survivor, N = 107 <sup>a</sup>	Non-Survivors, N = 50 <sup>a</sup>	
<b>Symptoms</b>					
Cough	157	97 (62%)	74 (69%)	23 (46%)	0.005
Fever	157	108 (69%)	75 (70%)	33 (66%)	0.61
Difficulty breathing	157	67 (43%)	40 (37%)	27 (54%)	0.050
Malaise	157	47 (29.9%)	46 (43%)	1 (2.0%)	<0.001
Headache	157	17 (11%)	17 (16%)	0 (0%)	0.003
Gastrointestinal symptoms	157	13 (8.3%)	8 (7.5%)	5 (10%)	0.76
Others	157	9 (5.7%)	4 (3.7%)	5 (10%)	0.14
<b>Vitals</b>					
Respiratory rate (breaths/min)	157	24 (20–30)	23 (19–26)	28 (24–33)	<0.001
Systolic blood pressure (mmHg)	157	126 (117–140)	128 (120–140)	123 (109–140)	0.11
Diastolic blood pressure (mmHg)	157	80 (70–87)	80 (74–87)	78 (60–84)	0.073
SpO <sub>2</sub> (%)	157	92 (88–96)	94 (90–96)	88 (78–93)	<0.001
Heart rate (beats/min)	157	98 (85–110)	93 (84–105)	104 (90–120)	<0.001

**Notes:** <sup>a</sup>Median (IQR) or frequency (%), <sup>b</sup>Wilcoxon rank sum test; Fisher's exact test; Pearson's Chi-squared test.

**Abbreviation:** SpO<sub>2</sub>, oxygen saturation.

**Table 3** Type of Initial Respiratory Support, Chest X-Ray Findings, Admitting Ward and Severity of the Disease on Admission

Variable	N	Overall, N = 157 <sup>a</sup>	Patient Outcome		p-value <sup>b</sup>
			Survivor, N = 107 <sup>a</sup>	Non-Survivors, N = 50 <sup>a</sup>	
<b>Initial support</b>					
No support	157	52 (33%)	50 (47%)	2 (4.0%)	<0.001
Nasal prongs		25 (16%)	22 (21%)	3 (6.0%)	
Face mask		12 (7.6%)	5 (4.7%)	7 (14%)	
Non-rebreather mask		62 (39%)	29 (27%)	33 (66%)	
Intubated		6 (3.8%)	1 (0.9%)	5 (10%)	
<b>Chest x-ray</b>					
Normal	135	20 (15%)	19 (21%)	1 (2.2%)	0.029
Bilateral patchy shadowing		46 (34%)	26 (29%)	20 (43%)	
Ground glass opacities		32 (24%)	19 (21%)	13 (28%)	
Interstitial abnormalities		9 (6.7%)	5 (5.6%)	4 (8.7%)	
Local patchy shadowing		12 (8.9%)	9 (10%)	3 (6.5%)	
Others		16 (12%)	11 (12%)	5 (11%)	
<b>Admitted to</b>					
General ward	157	99 (63%)	85 (79%)	14 (28%)	<0.001
HDU		29 (18%)	13 (12%)	16 (32%)	
ICU		29 (18%)	9 (8.4%)	20 (40%)	
<b>Severity</b>					
Moderate	157	51 (32%)	48 (45%)	3 (6.0%)	<0.001
Severe		61 (39%)	48 (45%)	13 (26%)	
Critical		45 (29%)	11 (10%)	34 (68%)	

**Notes:** <sup>a</sup>Median (IQR) or frequency (%), <sup>b</sup>Fisher's exact test; Pearson's Chi-squared test.

**Abbreviations:** HDU, high dependency unit; ICU, intensive care unit.

**Table 4** Laboratory Parameters on Admission

Variable	N	Overall, N = 157 <sup>a</sup>	Patient Outcome		p-value <sup>b</sup>
			Survivor, N = 107 <sup>a</sup>	Non-Survivors, N = 50 <sup>a</sup>	
WBC (10 <sup>9</sup> /L)	154	7.9 (5.7–10.8)	7.2 (5.4–9.4)	10.4 (6.3–14.9)	<0.001
< 4		8 (5.2%)	6 (5.8%)	2 (4.0%)	
4–10		98 (64%)	77 (74%)	21 (42%)	
> 10		48 (31%)	21 (20%)	27 (54%)	
ANC (10 <sup>9</sup> /L)	154	5.9 (3.8–9.2)	5.4 (3.5–8.0)	8.3 (5.0–13.9)	<0.001
< 1.8		3 (1.9%)	3 (2.9%)	0 (0%)	
1.8–6.3		81 (53%)	62 (60%)	19 (38%)	
> 6.3		70 (45%)	39 (38%)	31 (62%)	
ALC (10 <sup>9</sup> /L)	154	0.89 (0.65–1.45)	0.88 (0.65–1.37)	1.00 (0.67–1.63)	0.47
< 0.8		64 (42%)	44 (42%)	20 (40%)	
0.8–1.0		20 (13%)	15 (14%)	5 (10%)	
> 1.0		70 (45%)	45 (43%)	25 (50%)	
CRP (mg/L)	151	134 (52–267)	109 (47–220)	207 (90–301)	0.004
< 50		37 (25%)	29 (28%)	8 (17%)	
50–100		23 (15%)	18 (17%)	5 (10%)	
100–200		37 (25%)	26 (25%)	11 (23%)	
> 200		54 (36%)	30 (29%)	24 (50%)	
LDH (IU/L)	139	446 (304–576)	392 (282–533)	504 (412–728)	0.002
≤ 225		16 (12%)	14 (15%)	2 (4.3%)	
> 225		123 (88%)	79 (85%)	44 (96%)	
D-dimer (mg/L)	134	0.68 (0.39–1.93)	0.58 (0.35–1.34)	1.44 (0.58–5.74)	<0.001
< 0.5		46 (34%)	39 (41%)	7 (18%)	
0.5–1.0		32 (24%)	21 (22%)	11 (28%)	
> 1.0		56 (42%)	34 (36%)	22 (55%)	
Ferritin (µg/L)	118	928 (525–1843)	960 (525–1905)	829 (563–1573)	0.79
Unknown		39	21	18	
< 250		19 (16%)	14 (16%)	5 (16%)	
250–500		10 (8.5%)	7 (8.1%)	3 (9.7%)	
> 500		88 (75%)	65 (76%)	23 (74%)	
INR	72	1.15 (1.10–1.34)	1.13 (1.07–1.27)	1.25 (1.15–1.64)	0.007
0–1		4 (5.6%)	3 (6.5%)	1 (3.8%)	
1.0–1.5		56 (78%)	38 (83%)	18 (69%)	
> 1.5		12 (17%)	5 (11%)	7 (27%)	
BUN (mmol/L)	118	5.9 (3.9–9.9)	5.0 (3.3–7.6)	8.2 (4.8–12.4)	<0.001
≤ 9.5		87 (74%)	60 (83%)	27 (59%)	
> 9.5		31 (26%)	12 (17%)	19 (41%)	
Creatinine (µmol/L)	127	85 (72–114)	82 (71–101)	95 (76–134)	0.040
≤ 104		88 (69%)	63 (79%)	25 (53%)	
> 104		39 (31%)	17 (21%)	22 (47%)	
AST (IU/L)	81	49 (29–83)	38 (25–66)	64 (42–99)	0.007
≤ 40		34 (42%)	27 (54%)	7 (23%)	
> 40		47 (58%)	23 (46%)	24 (77%)	
ALT (IU/L)	82	35 (22–65)	40 (22–67)	33 (22–54)	0.57
≤ 41		46 (56%)	25 (50%)	21 (66%)	
> 41		36 (44%)	25 (50%)	11 (34%)	

Notes: <sup>a</sup>Median (IQR) or frequency (%) <sup>b</sup>Wilcoxon rank sum test; Fisher's exact test; Pearson's Chi-squared test.

**Abbreviations:** ANC, absolute neutrophil count; ALC, absolute lymphocyte count; CRP, C-reactive protein; LDH, lactate dehydrogenase; INR, international normalized ratio; BUN, blood urea nitrogen; AST, aspartate aminotransferase; ALT, alanine aminotransferase; <, less than; >, more than.



D-dimer 1.44 mg/L (IQR 0.58–5.74) and deranged International Normalized Ratio (INR) 1.25 (IQR 1.15–1.64) were noted amongst the non-survivors ( $P < 0.05$ ). Absolute lymphocyte counts and ferritin levels did not reveal any statistical significant difference when survivors and non-survivors were compared.

Table 5 illustrates the risk factors associated with increased risk of mortality. In the univariable analysis, the odds of in-hospital mortality were higher in advanced age, those suffering from diabetes mellitus, hypertension or both. Being overweight and obese, suffering with severe form of illness, requiring oxygen supplementation on admission and being admitted to the ICU and HDU were other factors associated with increased odds of in-hospital mortality. In the multivariable logistic regression model, we found advanced age (OR 1.07,

95% CI 1.03–1.11), overweight and obesity (OR 9.44, 95% CI 2.71–41.0), severe form of the disease (OR 4.77, 95% CI 1.18–25.0) and being admitted to the HDU and ICU (OR 6.68, 95% CI 2.06–24.6) to be the primary factors associated with higher odds of in-hospital mortality.

## Discussion

The in-hospital mortality amongst our cohort was 31.8%. Our study identified several risk factors associated with mortality amongst hospitalized patients with COVID-19 in a Tanzanian setting. The in-hospital mortality was lower compared to the average mortality reported in Africa<sup>8</sup> but higher than the global average amongst hospitalized patients with COVID-19.<sup>23</sup> Our study identified advanced age, overweight and obesity, severe form of the illness and

**Table 5** Factors Associated with Increased Odds of Mortality Among Patients Suffering with COVID-19

Variable	Univariable Analysis			Multivariable Analysis		
	OR	95% CI	P-value	OR	95% CI	P-value
Age (years)	1.05	1.02–1.08	<0.001	1.07	1.03–1.11	0.001
Diabetes mellitus						
No	Ref					
Yes	2.11	1.05–4.28	0.037			
Hypertension						
No	Ref					
Yes	2.87	1.39–5.96	0.004			
Diabetes mellitus & hypertension						
No	Ref					
Yes	4.07	1.84–9.23	<0.001	1.71	0.48–6.24	0.400
Comorbids						
With	Ref					
Without	0.07	0.02–0.20	<0.001			
BMI						
Healthy weight	Ref					
Overweight & obese	7.14	2.78–22.2	<0.001	9.44	2.71–41.0	0.001
Severity						
Non severe	Ref					
Severe	12.7	4.32–54.7	<0.001	4.77	1.18–25.0	0.039
Admitting ward						
Isolation ward	Ref					
CCU (HDU & ICU)	9.94	4.68–22.2	<0.001	6.68	2.06–24.6	0.002
Initial oxygen support						
No	Ref					
Yes	21.1	6.09–133.0	<0.001			
D-dimer > 1 mg/L	1.34	1.13–1.59	<0.001			

admission to the CCU (HDU & ICU) as the main factors associated with higher odds of mortality.

Studies have shown adults are more likely to suffer with severe form of the disease. The median age of hospitalized patients with COVID-19 ranges from 49 to 56 years.<sup>4,24,25</sup> Our study findings are consistent with reports published globally and comparable to other studies done in Africa.<sup>8,26</sup> Elderly and males have been found to be at an increased risk of mortality, this has been associated with the higher levels of angiotensin-converting enzyme 2 (ACE2), which is a cell surface receptor for SARS-CoV-2.<sup>27</sup> Nevertheless, our study did not find any association between gender and increased odds of mortality.

Our study also identified obesity to be significantly associated with in-hospital mortality. Our findings are consistent with those done in the United States<sup>15,28</sup> but contrary to study findings from ten different countries in Africa.<sup>8</sup> We hypothesize the difference could be in part due to the large cohort of the foreign community which our center serves. The spectrum of COVID-19 ranges from mild to critical; however, most individuals suffer from mild form of the disease.<sup>9</sup> In our cohort, more than half of the patients who died were admitted to the HDU and ICU, suffering from the critical form of illness. Similar reports of ICU mortality due to COVID-19 have been reported globally.<sup>29-31</sup> It is unfortunate the limited scope of our study cannot identify the causes of high mortality in our ICU setting as there is no readily available data. However globally, acute respiratory distress syndrome (ARDS),<sup>10,12</sup> cardiovascular,<sup>16,25,32</sup> thromboembolic<sup>33,34</sup> and neurologic complications<sup>35</sup> have been reported as the main cause of mortality in ICU patients suffering with critical forms of COVID-19.

Our study results are concordant with reported risk factors of COVID-19 mortalities worldwide. Our study had several limitations. This was a single-center observational cohort study in a well-resourced private health-care setting, thus limiting the generalizability of our results to public facilities. Lack of national guidelines at the time of the study hindered development, validation and application of appropriate clinical and radiological scoring systems. Additionally, the retrospective study design restricted us from following up our patients after hospital discharge. Despite these limitations, the experience and the data analyzed have set a benchmark for more research in addressing areas of clinical improvement within Tanzania.

## Conclusion

This is the first and the largest study done in Tanzania of hospitalized COVID-19 patients. This study not only provides a comprehensive assessment of the clinical spectrum of COVID-19 patients admitted to our specific urban setting but also highlights the factors associated with increased risk of mortality amongst our cohort. We found that the in-hospital mortality was lower compared to the average mortality reported in Africa. More importantly, age, obesity, severe form of the disease and admission to ICU and HDU were factors strongly associated with increased risk of mortality.

## Data Sharing Statement

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

## Ethics Approval and Consent to Participate

The study was approved by the Aga Khan University, East Africa Ethical Research Committee (AKU, EA ERC). The National Institute for Medical Research (NIMR) mandates the AKU, EA ERC to approve health research conducted by Tanzanian staff and students under the Act of Parliament No. 23 of 1979 and its amendments in 1997. Informed consents from study participants were exempted, since the study design did not affect the rights and welfare of the patients. This study was conducted in accordance with the Declaration of Helsinki.

## Acknowledgments

Special thanks to the whole team working in the COVID-19 ward at the Aga Khan Hospital, Dar es Salaam, Tanzania.

## Author Contributions

All authors made a significant contribution to the work reported, whether that is in the conception, study design, execution, acquisition of data, analysis and interpretation, or in all these areas; took part in drafting, revising or critically reviewing the article; gave final approval of the version to be published; have agreed on the journal to which the article has been submitted; and agree to be accountable for all aspects of the work.

## Disclosure

The authors report no conflicts of interest in this work.

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