Factors associated with COVID-19 inpatient mortality cases within 24 hours in South Africa

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Background. African countries with limited healthcare capacity are particularly vulnerable to the novel coronavirus (COVID-19). The pandemic has left health systems short on resources to safely manage patients and protect healthcare workers. South Africa (SA) is still battling the epidemic of HIV/AIDS and tuberculosis (TB), which had their programme/services interrupted due to the effects of the pandemic. Lessons learnt from the HIV/AIDS and TB programme have shown that South Africans delay seeking health services when a new disease presents itself.

Objective. To investigate the risk factors for COVID-19 inpatients' mortality within 24 hours of hospital admission in public health facilities in Limpopo Province, SA.

Methods. The study used retrospective secondary data obtained from the 1 067 clinical records of patients admitted between March 2020 and June 2021 by the Limpopo Department of Health (LDoH). A multivariable logistic regression model, both adjusted and unadjusted, was used to assess the risk factors associated with COVID-19 mortality within 24 hours of admission.

Results. This study, which was conducted in Limpopo public hospitals, discovered that 411 COVID-19 patients (40%) died within 24 hours of admission. The majority of the patients were aged ≥60 years, mostly of female gender, and had comorbidities. In terms of vital signs, most had body temperatures <38°C. Our study findings revealed that COVID-19 patients who present with fever and shortness of breath were 1.8 and 2.5 times more likely to die within 24 hours of admission to the hospital, respectively, than patients without fever and with normal respiratory rate. Hypertension was independently associated with mortality in COVID-19 patients within 24 hours of admission, with a high odds ratio (OR) for hypertensive patients (OR 1.451; 95% confidence interval 1.013 - 2.078) compared with non-hypertensive patients.

Conclusion. Assessing demographic and clinical risk factors for COVID-19 mortality within 24 hours of admission aids in understanding and prioritising patients with severe COVID-19 and hypertension. Finally, this will provide guidelines for planning and optimising the use of LDoH healthcare resources, and also aid in public awareness endeavours.

The world came to a halt as a result of the coronavirus (COVID-19) pandemic. The COVID-19 pandemic has had a significant impact on social, economic and population health around the world, and the end date of the outbreak is unknown.[1-4] African countries with limited healthcare capacity were particularly vulnerable to the novel coronavirus.[4-6] In some countries, the pandemic left health systems short of resources to safely manage patients and protect healthcare workers.[6] South Africa (SA) is one of the developing countries still battling HIV/AIDS and tuberculosis (TB), leaving the country unsure of how the pandemic will progress.[7,8] COVID-19 presents as a complicated clinical illness with a potential for complications that may necessitate ongoing clinical care.[9,10] The disease's clinical manifestation can be mild, moderate to severe or critical.

According to recent studies, the most common symptoms of COVID-19 at the onset of the illness were fever, cough, fatigue, dyspnoea and headache.[11,12] Excess mortality has been reported in studies conducted worldwide, which are associated with comorbidities such as cancer, chronic kidney diseases, diabetes mellitus and hypertension.[11,13,14] Behavioural risk factors such as being a smoker were also noted as associated factors of COVID-19.[15] Length of hospital stay was significantly associated with severe COVID-19 patients.[12]

The length of hospital stay varies by country, with the USA, Italy and Germany having 2 - 10, 1 - 6 and 5 - 19 days, respectively, and China having 4 - 53 days.[16,17] Studies conducted in SA reported a median length of stay of 7 - 8 days in previous waves (1, 2 and 3) and 3 days in wave 4.[18] Patients who present with breathing difficulties, incident organ failure, a low leukocyte count, age >60 years and a high blood urea nitrogen level should be expected to stay in the hospital for an extended period.[11,19] However, our knowledge of the literature on risk factors for mortality in public hospitals within 24 hours of patient admission is limited, particularly in SA. The present study sought to fill a gap in the literature by investigating risk factors for COVID-19 inpatient mortality within 24 hours of hospital admission in public health facilities in Limpopo Province, SA. This will aid in COVID-19 prevention and public awareness endeavours, as well as the planning and allocation of health resources in public hospitals.

Methods

Study setting, period and design

This study was carried out in Limpopo Province using retrospective secondary COVID-19 data from the Limpopo Department of Health (LDoH)'s public hospitals across all districts. Limpopo Province has

41 public hospitals that admitted COVID-19 patients referred from home, clinics and other hospitals. The study used retrospective secondary data collected from 1 067 patients' clinical records of laboratory-confirmed COVID-19 cases admitted between March 2020 and June 2021. Non-laboratory-confirmed COVID-19 cases were excluded. In our previous study, it was reported that Capricorn had the highest case fatality rate (CFR) (4%), followed by Vhembe (3.9%), then Mopani (3.8%), with Waterberg (3.1%) and Sekhukhune (2.5%) having the smallest CFRs.[14] Furthermore, the overall Limpopo Province COVID-19 inpatient CFR was 3.55 (cumulative admission cases = 63 473 and COVID-19 deaths cases = 2 256).

Statistical analysis

The data were retrieved from LDoH databases, coded, recorded and entered into Excel (Microsoft Corp., USA) before being imported into the Statistical Package for Social Sciences (SPSS) version 26 (IBM Corp., USA) for further analysis. The information was presented in the form of frequency and percentages. A multivariable logistic regression model, both adjusted for gender and unadjusted, was used to assess the clinical risk factors associated with COVID-19 mortality within 24 hours of admission in Limpopo Province, SA. All statistical analyses were carried out using SPSS version 26, and predictor variables were presented using both adjusted and unadjusted odds ratios (ORs) at 95% confidence intervals (CIs). The statistical significance was set at 5%.

Ethical approval

The study was approved by the University of Limpopo Research Ethics Committee (ref. no. TREC/293/2021: IR) and the Limpopo Provincial Health Research Committee (ref. no. LP_2021-11-017).

Results

Table 1 shows the total cases of inpatient admissions and the case fatality rate within 24 hours of admission in Limpopo Province's five districts. COVID-19 patients admitted to the hospital had the highest mortality rate within 24 hours in the Sekhukhune and Mopani districts. Patients aged ≥60 years showed the highest proportion of patients dying within 24 hours of admission to the hospital (Fig. 1). The lowest rate was observed in patients between 10 and 30 years of age. Furthermore, patients with body temperatures ranging from 0°C to 30°C had the highest proportion of patients dying within 24 hours of being admitted to the hospital (Table 1). A total of 411 (40%) COVID-19 patients died within 24 hours of admission.

Of the 1 067 hospitalised COVID-19 patients, the majority were hypertensive (*n*=683, 64%), followed by those suffering from diabetes mellitus (*n*=555, 52%) (Fig. 2). In terms of the clinical presentations of these COVID-19 patients, shortness of breath was common (*n*=896, 84%), followed by coughing (*n*=865, 81%) (Fig. 3). The study also observed that a small proportion of COVID-19 patients admitted to hospitals did not have any COVID-19 symptoms (*n*=29).

The logistic regression of the association between COVID-19 mortality within 24 hours of hospital admission and the clinical presentations before admission are illustrated in Table 2. There was a significant (*p*<0.05) association between COVID-19 mortality within 24 hours of hospital admission and shortness of breath among admitted COVID-19 patients, both unadjusted (OR 2.387; 95% CI 1.307 - 4.359) and adjusted (OR 2.565; 95% CI 1.390 - 4.734) for gender. Only the adjusted model revealed a significant association between COVID-19 mortality within 24 hours of hospital admission and fever (OR 1.832; 95% CI 1.035 - 3.243) and coughing (OR 0.552; 95% CI 0.306 - 0.997).

The logistic regression of the association between COVID-19 mortality within 24 hours of hospital admission and comorbid conditions before admission is illustrated in Table 3. There was a significant (*p*<0.05) association between COVID-19 mortality within 24 hours of hospital admission and hypertension among admitted COVID-19 patients, both unadjusted (OR 1.450; 95% CI
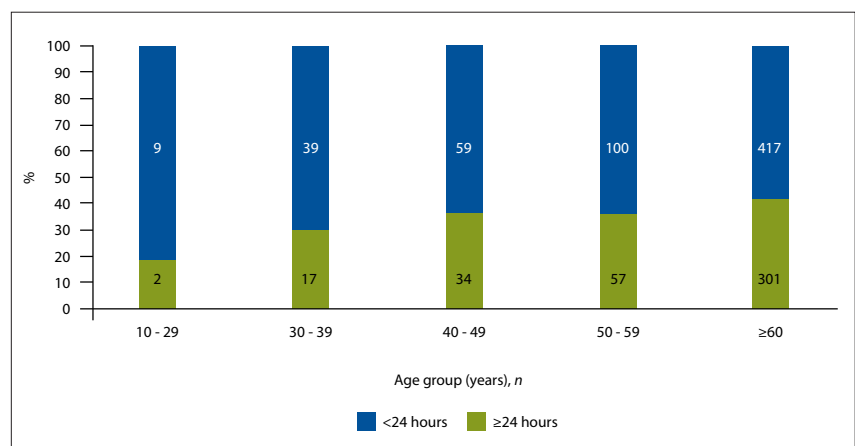

Fig. 1. COVID-19 patient deaths within 24 hours of admission, by age group, n (N=1 067).

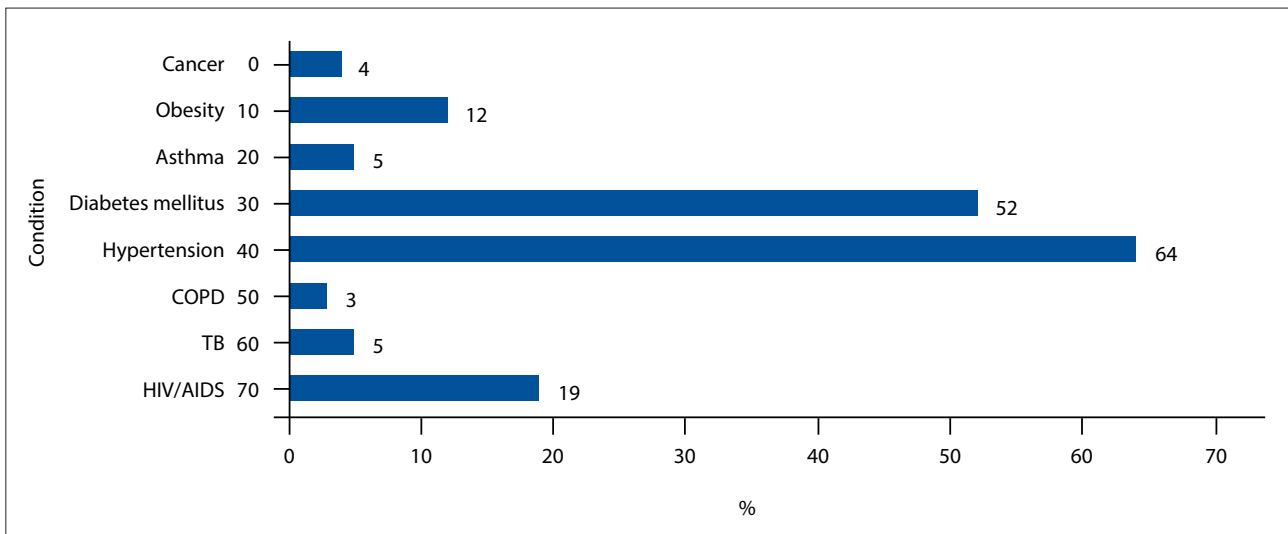| Table 1. Confirmed COVID-19 cases and mortality rate within 24 hours of admission			
	Cumulative cases, *n*	Deaths, *n*	Case fatality rate, %
Capricorn	475	177	37
Mopani	198	73	37
Sekhukhune	92	39	42
Vhembe	268	109	41
Waterberg	34	13	38
Total	1 067	411	39
Body temperature, °C			
0 - 37	777	320	41
38 - 39	129	51	40
39 - 40	33	3	9
Total	939	374	40
Total	939	374	40

Fig. 2. Underlying conditions among hospitalised COVID-19 patients (N=1 067). (COPD = chronic obstructive pulmonary disease; TB = tuberculosis.)
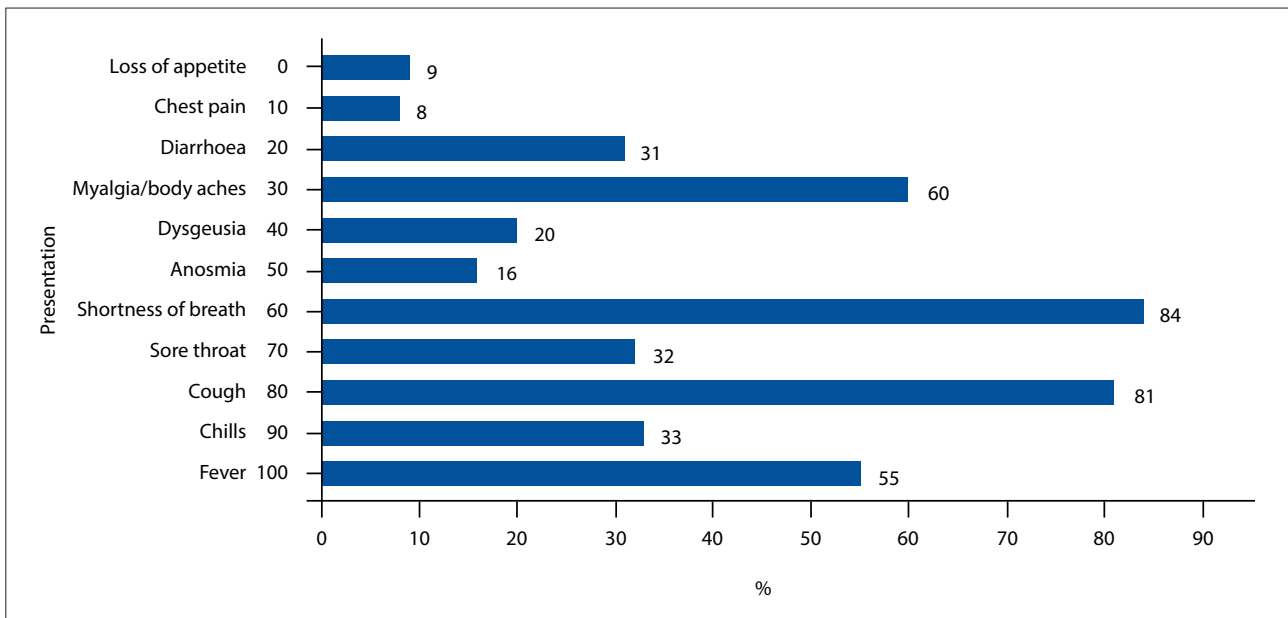

Fig. 3. Clinical presentations among hospitalised COVID-19 patients.

1.012 - 2.078) and adjusted (OR 1.451; 95% CI 1.013 - 2.078) according to gender.

Discussion

This study determined factors associated with death among COVID-19 admitted patients in public hospitals in Limpopo Province. The study found a high COVID-19 inpatient case fatality rate within 24 hours of patient hospitalisation in the Sekhukhune and Mopani districts. To the best of our knowledge, this could be due to both patient and health system factors, such as late patient presentation and long hospital turnaround times (TAT) for COVID-19 laboratory results. According to a study done at Dhulikhel Hospital-Kathmandu University Hospital, Nepal, to determine the factors influencing TAT in the clinical laboratory, nearly 36% of reports exceeded the predefined TAT, while only 7% of reports for routine tests did so.[20] Around 75% of reports with prolonged TAT were delayed for various additional analytical reasons, and 48% of all delayed reports were only discovered due to error by cash unit.

For both males and females, the highest percentage of COVID-19 deaths occurred between the ages of 55 and 59 years and 60 and 64 years, respectively.[11,19] Our study found similar results, with patients aged ≥50 years having the highest mortality rate and patients between 10 and 30 years of age recording the lowest mortality rate. Overall, patients who died within 24 hours of hospitalisation had body temperatures <38°C. Our findings are similar to those of the study by Tharakan *et al.*,[21] who reported that low body temperature at the time of COVID-19 patient hospitalisation is associated with a poor prognosis. Another study found that about a quarter of patients who tested positive for COVID-19 did not have a fever of >38°C at their arrival.[22] Higher body temperature at initial presentation did not show a significant association with mortality.[21,22]

The literature shows that gender, fever, chronic kidney or liver disease before admission and increasing creatinine levels were associated with prolonged length of stay in patients with COVID-19.[11,13] Our study findings revealed that COVID-19 patients who presented with fever were 1.8 times more likely to die within 24 hours of admission to hospital than patients without fever. In

Table 2. Unadjusted and adjusted multivariable logistic regression model to assess the clinical presentation risk factors associated with COVID-19 mortality

Clinical presentation	Unadjusted		Adjusted for gender	
	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
Fever	1.745 (0.993 - 3.068)	0.053	**1.832 (1.035 - 3.243)**	**0.038**
Chills	0.833 (0.404 - 1.717)	0.620	0.850 (0.411 - 1.760)	0.662
Cough	0.568 (0.317 - 1.018)	0.057	**0.552 (0.306 - 0.997)**	**0.049**
Sore throat	0.743 (0.357 - 1.546)	0.427	0.762 (0.363 - 1.598)	0.472
Shortness of breath	**2.387 (1.307 - 4.359)**	**0.005**	**2.565 (1.390 - 4.734)**	**0.003**
Anosmia	2.683 (0.541 - 13.305)	0.227	2.653 (0.524 - 13.421)	0.238
Dysgeusia	1.641 (0.445 - 6.052)	0.457	1.670 (0.445 - 6.266)	0.447
Myalgia/body aches	0.852 (0.463 - 1.569)	0.608	0.830 (0.449 - 1.537)	0.554
Diarrhoea	0.856 (0.347 - 2.109)	0.735	0.847 (0.337 - 2.127)	0.724
Chest pain	0.749 (0.165 - 3.396)	0.708	0.864 (0.187 - 3.983)	0.851
Loss of appetite	0.817 (0.248 - 2.695)	0.740	0.740 (0.221 - 2.477)	0.626

OR = odds ratio; CI = confidence interval.
Bold = significant at 5% level.

Table 3. Unadjusted and adjusted multivariable logistic regression model to assess the comorbid conditions associated with COVID-19 mortality

Comorbid conditions	Unadjusted		Adjusted for gender	
	OR (95% CI)	*p*-value	OR (95% CI)	*p*-value
HIV/AIDS	0.645 (0.353 - 1.178)	0.154	0.648 (0.355 - 1.184)	0.158
Tuberculosis	0.998 (0.387 - 2.570)	0.996	1.034 (0.399 - 2.681)	0.945
COPD	0.803 (0.184 - 3.511)	0.771	0.813 (0.186 - 3.558)	0.784
Hypertension	**1.450 (1.012 - 2.078)**	**0.043**	**1.451 (1.013 - 2.078)**	**0.043**
Diabetes mellitus	0.946 (0.656 - 1.366)	0.768	0.943 (0.653 - 1.361)	0.754
Asthma	0.906 (0.369 - 2.220)	0.828	0.890 (0.362 - 2.187)	0.800
Obesity	0.950 (0.455 - 1.981)	0.890	0.945 (0.453 - 1.972)	0.880
Cancer	0.553 (0.164 - 0.862)	0.339	0.557 (0.165 - 1.873)	0.344

OR = odds ratio; CI = confidence interval; COPD = chronic obstructive pulmonary disease.
Bold = significant at 5% level.

contrast, Shi *et al.*[23] discovered that fever was not associated with an increased risk of mortality in COVID-19 patients. The difference in findings could also be attributed to the fact that our study focused on mortality within 24 hours of hospitalisation, and retrospective data collected for other purposes. Our study found that COVID-19 patients with a cough may have a lower risk of mortality within 24 hours of admission to hospital.

COVID-19 patients who presented with shortness of breath were found to be 2.5 times more likely to die within 24 hours of admission to the hospital than patients with no shortness of breath. These findings are consistent with recent studies that found shortness of breath to be positively associated with COVID-19 progressions, such as severe illness and death.[19,23] Shortness of breath in COVID-19 patients has a higher risk of mortality within 24 hours of admission. Anosmia, sore throat, dysgeusia, body aches, diarrhoea, chest pain and loss of appetite are some of the most common presenting symptoms of COVID-19.[15,24,25] However, in the present study, it was found that clinical presentations such as anosmia, sore throat, dysgeusia, body aches, diarrhoea, chest pain and/or loss of appetite were not significantly associated with COVID-19 mortality within 24 hours of admission. The discrepancy could be attributed to the fact that these were new symptoms discovered following the pandemic's second wave. Between March and August of 2020, no data were collected on patients regarding these variables.

The most common comorbidities among COVID-19 patients were hypertension (58.3%), diabetes mellitus (29.8%) and heart disease.[15,26-28] Diabetes mellitus and hypertension were reported in previous studies as independently associated with mortality in COVID-19 patients, with chronic kidney disease being the most common comorbidity leading to death.[27-29] These results are comparable with our study results, which show that the odds of COVID-19 patients with hypertension dying within 24 hours of admission to the hospital are ~50% higher than the odds of normotensive patients dying within 24 hours of admission to the hospital (OR 1.450; 95% CI 1.012 - 2.078). It was found that common comorbidities such as HIV/AIDS, TB, diabetes mellitus, obesity and cancer are not significantly associated with COVID-19 mortality within 24 hours of admission. This contradicts previous studies that show a statistically significant link between HIV/AIDS, TB, diabetes and obesity and COVID-19 death.[30-33] However, one meta-analysis study found that people living with HIV had a higher risk of COVID-19 mortality than those who did not have HIV infection in the USA and SA, but no significant association was found in the UK.[34] The differences in the findings could be attributed to differences in location, population age, other demographic/social factors and HIV prevalence, as there were few HIV-infected patients in the present study. This was a retrospective secondary study using clinical records. One limitation is that records/files with missing information were excluded, which might have lost valuable information, and influenced the findings negatively. In addition, the study excluded clinical records of non-laboratory-confirmed COVID-19 cases.

Conclusion

This study used data from all 41 public hospitals in Limpopo Province and found that 411 COVID-19 patients (40%) died within 24 hours of admission. Patients who presented at the hospital with shortness of breath, fever and hypertension were at higher risk of dying within 24 hours. Assessing risk factors for COVID-19 mortality within 24 hours of admission will assist in determining intervention to prevent late presentation, and aid the understanding and prioritising of patients with severe/critical COVID-19 and comorbidities such as hypertension.

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