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Clinico-Epidemiological Characteristics and Survival Outcomes of COVID-19 Infection in Kassala, Eastern Sudan

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Abstract

Introduction: Severe acute respiratory syndrome coronavirus2 (SARS-CoV-2) represents a major health problem worldwide. Thus, early detection and appropriate management of the virus will influence the outcome of the disease. This study aimed to investigate the epidemiological characteristics and survival outcomes of patients with COVID-19 infection in Kassala, Eastern Sudan. **Methods:** A cross-sectional hospital-study was conducted among patients visiting Kassala teaching hospital with suspicion of COVID-19 infection. A structured questionnaire was used to gather clinical and socio-demographic information from COVID-19 patients. Nasopharyngeal specimens and blood samples were collected and tested to confirm the diagnosis of COVID-19 infection using RT-PCR. **Results:** A total of 371 patients were enrolled in the study from September 2020 to January 2021, with mean age ± SD was 42.9 ± 19.9. The prevalence of COVID-19 infection was estimated at 61.7%. The majority were males 159 (69.4%), of university-level education, 96 (49.7%), and urban residents, 175 (9.7%). The most common symptoms were fever 215 (93.9%), cough 188 (82.1%), headache 179 (78.2%), and shortness of breath 154 (67.2%). Overall all mortality was reported as 16%. Older age group with the age ≥ 70, $P < 0.001$, Hypertension $P = 0.020$, diabetes mellitus

P = 0.029 were significantly associated with high case fatality. **Conclusion:** This study demonstrated that older age, male gender, laboratory tests (leukocytosis, lymphopenia, low Hemoglobin and high CRP) and various comorbid conditions significantly increase the disease severity and mortality. Therefore, attention should be paid to preventive measures to reduce the considerable impacts of the disease.

Keywords

COVID-19, Infection, Epidemiology, Outcome, Sudan

1. Introduction

The COVID-19 pandemic represents one of the worst pandemics in the history of humanity [1] [2]. It is caused by SARS-CoV-2, which is a novel RNA virus that is phylogenetically closely related to the previous two viruses that caused the Severe Acute Respiratory Syndrome (SARS) epidemics in 2003 and Middle East Respiratory Syndrome (MERS) in 2011 [3] [4]. The first case of COVID-19 was reported globally in December 2019 [5]. Then the infection spread quickly, sparing almost no country in the world. As of 12th November 2022, more than 630 million cases of COVID-19 have been reported globally, including more than 6.5 million deaths [6].

SARS-CoV-2 infection can occur in all age groups, with clinical spectrum ranging from asymptomatic infection to severe disease that can lead to hospitalization and death. According to Early reports in USA, 14% of all confirmed cases required hospitalization, 2% were admitted to the intensive care unit, and 5% died [7]. Hospitalization and death is more common in the elderly (above 65 years) and those with underlying medical conditions. The latter include diabetes, cardiovascular disease, chronic lung disease, cancer, kidney disease, liver disease, obesity, sickle cell disease, and other immunocompromising conditions [8] [9] [10] [11].

In Sudan, the first confirmed cases of COVID-19 were identified in March 2020 [12]. Despite the preventive measures implemented by the Sudan government, the cases have steadily increased, and the initial case-fatality rates are estimated to be 7.7% according to deaths reported by the end of 2020 [13]. As of 11th November 2022, the total case reported to the World Health Organization is 63,561, including 4980 deaths [14].

There is little data published in Sudan regarding the COVID-19 infection; therefore, this study aimed to document the local experience of Kassala Teaching Hospital, the major center dealing with COVID-19 cases in Kassala state, eastern Sudan, by describing the clinical and epidemiological characteristics of COVID-19 patients, mainly during the second wave of the pandemic. In view of the scarcity of resources in this part of Sudan, the results of this study could be useful to inform the health policy and to guide the preventive strategies and the vaccina-

tions campaigns to mitigate the risks of the ongoing COVID-19 pandemic.

2. Material and Methods

2.1. Study Design and Specimen Collection

Across-sectional, hospital-based study was conducted in Kassala state, Eastern Sudan, from September 2020 to January 2021. After signing informed consent, all suspected COVID-19 patients who attended the COVID-19 isolation center at Kassala Teaching hospital were enrolled in the study. Ethical approval was obtained from the ministry of health, Kassala State, and Faculty of Medical Laboratory Sciences, University of Gezira, Sudan (Ethical approval number: 9). Patients' demographics and clinical data were collected using a structured questionnaire that included the age, occupation, residence, educational level, symptoms and signs of patients, and the patients' medical history. Samples for the detection of COVID-19 were collected from the nasopharynx using nasopharyngeal swabs. Nasopharyngeal specimens were collected then the swabs were put into a viral transport medium (VTM) and transported to the laboratory for RNA extraction. In addition, blood samples were collected and separated in EDTA, lithium heparin, and sodium citrate anticoagulant containers for other laboratory tests, including Complete Blood Count, bleeding profiles, ESR, CRP level, and renal function tests. The patients classified to mild, moderate and severe according to the WHO criteria [15].

2.2. RNA Extraction and the Molecular Detection of SARS-CoV-2

According to the manufacturer's instructions, the viral RNA was extracted using Da An Gene RNA extraction kits (Da An Gene Co., Ltd., China). Briefly, 200 µl of the VTM was taken into a mixture contains 50 µl of proteinase K, 204 µl of lysis solution (200 µl lysis buffer and 4 µl Carrier RNA) and then incubated in a heating block at 72˚C for 10 minutes. Then, 250 µl of absolute ethanol was added, mixed for 15 seconds, and drawn into the spin column. Several washing steps were made using the inhibitor remover solution through multiple centrifugations; twice. Finally, the RNA was eluted in 50 µl of preheated elution buffer and stored at −80 C until molecular examinations. To rapidly detect SARS-Cov-2, the real-time PCR was conducted using Da An Gene SARS-CoV viral detection kits following the manufacturer's instructions (Da An Gene Co., Ltd. China).

3. Data Analysis

Patients' demographics and clinical data were entered and analyzed using the statistical package for social science software (SPSS, v 24). Shapiro-Wilk normality test was used to test the normal distribution of data among the studied population. Means and proportions of the socio-demographic and epidemiological characteristics were calculated for symptomatic COVID-19 groups using the student t-test and x^2 test, respectively. Confidence intervals of 95% were calculated, and $P < 0.05$ was considered statistically significant.

4. Results

A total of 371 patients with suspicion of COVID-19 infection were enrolled in this study, out of 229 confirmed as having COVID-19, giving a prevalence of (61.7%). Of these 159 (69.4%) were male and 70 (30.6%) were female, giving an M:F ratio of 2, 3:1. Their age ranged from 10 to 70 years with the mean age of (43.3 ± 19.8) years (Table 1). The majority were of university-level of education, 103 (45%) and urban residents, 207 (90.4%). History of close contact with a COVID-19 patient was noted in 81 (35.4%) of whom 68 (35.2%) were recovered, while 13 (36.1%) died (Table 2). There was significant association between the age group of ≥70 years and COVID-19 infection 56 (24.5%); likewise, high case fatality was observed among the same age group 20 (55.6%) $P = 0.001$. By contrast, COVID-19 infection was negatively associated with the age group of 20 - 29 years. Our study noticed that, males 159 (69.4%) had higher risk of COVID-19 infection and high mortality compared with women 70 (30.6%) (Table 2). Although the University-level of education in this study was significantly related to COVID-19 infection 103 (45%) $P = 0.001$, it was also associated with lower levels of education such as illiterate and primary levels of education 42 (18.3%) $P = 0.003$, and 52 (22.7%) $P = 0.037$, respectively (Table 2).

Table 1. Showing the Mean ± Std of age and laboratory tests of COVID-19 patients.

Variables	Recovered (mean± Std. Error) n = 193	Death (mean± Std. Error) n = 36	Minimum	Maximum	*P*-value
Age (years)	43.5 ± 1.36	68.6 ± 3.27	3	100	<0.001
Total White Blood Cells (TWBCs) (10^3/μL)	11.7 ± 0.3	13.12 ± 0.79	1.6	41.6	0.111
Red Blood Cells (RBCs) (10^3/μL)	4.43 ± 0.03	4.34 ± 0.12	2.8	6.18	0.516
Hemoglobin (Hb) (g/dl)	12.4 ± 0.12	12.3 ± 0.12	8.9	17.2	0.831
Platelets (PLT) (10^3/μL)	287 ± 7.36	262 ± 21. 6	98	796	0.283
Lymphocyte (%)	13.8 ± 0.5	11.2 ± 1.27	1	55.4	0.055
Neutrophil (%)	77.9 ± 0.67	80.9 ± 1.5	35	97.6	0.085
Prothrombin Time (PT) (Seconds)	15.4 ± 0.21	17.8 ± 0.55	12.4	22.9	<0.001
Partial Thromboplastin Time (PTT) (Seconds)	39.2 ± 0.57	44.9 ± 1.3	27.9	55.2	<0.001
International Normalized Ratio (INR)	1.10 ± 0.02	1.29 ± 0.04	0.81	1.68	<0.001
Erythrocyte Sedimentation Rate (ESR) (mm/h)	39.8 ± 1.7	70 ± 4.1	5	135	<0.001
C-Reactive Protein level (CRP) (mg/l)	18.5 ± 1.2	43.5 ± 4.3	2	110	<0.001
Blood urea (mg/dl)	30.3 ± 1.6	56.5 ± 9.6	10	267	0.011
Serum Creatinine (mg/dl)	0.88 ± 0.04	1.6 ± 0.48	0.3	18	0.134
Serum Sodium (mmol/l)	137 ± 0.28	138 ± 0.73	120	155	0.260
Serum Potassium (mmol/l)	3.82 ± 0.03	3.88 ± 0.10	2.5	5.7	0.552
Serum Calcium (mg/dl)	8.50 ± 0.07	8.08 ± 0.17	6.10	10.30	0.034

Table 2. Socio-demographical characteristics of COVID-19 patients in Kassala state, eastern Sudan.

Participants' demographics	Clinical outcome		Total n = 229	*P* value
	Recovered n = 193	Death n = 36		
Gender				
Male	131 (67.9%)	28 (77.8%)	159 (69.4%)	0.266
Female	62 (32.1%)	8 (22.2%)	70 (30.6%)	0.236
Age groups				
70 and more	36 (18.7%)	21 (58.3%)	57 (24.9%)	<0.001
60 to 69 years	17 (8.8%)	8 (22.2%)	25 (10.9%)	0.018
50 to 59 years	20 (10.4%)	1 (2.8%)	21 (9.2%)	0.148
40 to 49 years	18 (9.3%)	1 (2.8%)	19 (8.3%)	0.191
30 to 39 years	34 (17.6%)	2 (5.6%)	36 (15.7%)	0.068
20 to 29 years	60 (31.1%)	0 (0%)	60 (26.2%)	<0.001
10 to 19 years	7 (3.6%)	0 (0%)	7 (3.1%)	0.246
Educational level:				
University	96 (49.7%)	7 (19.4%)	103 (45%)	<0.001
Secondary	28 (14.5%)	3 (8.3%)	31 (13.5%)	0.320
Primary	39 (20.2%)	13 (36.1%)	52 (22.7%)	0.037
Illiterate	29 (15%)	13 (36.1%)	42 (18.3%)	0.003
Residence:				
Urban	175 (90.7%)	32 (88.9%)	207 (90.4%)	0.739
Rural	18 (9.3%)	4 (11.1%)	22 (9.6%)	0.739
History of contact:				
Direct contact	68 (35.2%)	13 (36.1%)	81 (35.4%)	0.919
Community exposure	125 (64.8%)	23 (63.9%)	148 (64.6%)	0.919

At presentation, 58 (25.3%) patients were in severe form of the disease while 71 (31%), 100 (43.7%) patients had mild to moderate disease respectively (Figure 1).

Regarding clinical manifestations at presentation, the most prevalent symptoms were fever 215 (93.9%), cough 188 (82.1%), shortness of breath 154 (67.2%), sore throat 186 (81.2%) and headache 179 (78.2%). Moreover, shortness of breath was significantly associated with high mortality 154 (67.2%), $P = 0.009$ (Table 2). The most common comorbidities among COVID-19 patients were diabetes 141 (61.6%), hypertension 13 (5.7%), renal impairment 14 (6.1%), asthma 21 (9.2%), epilepsy 12 (5.2%) and tuberculosis 13 (5.7%).

Several comorbidities like diabetes mellitus $P = 0.029$, Hypertension $P = 0.020$, and renal impairment $P < 0.0011$ and tuberculosis $P < 0.001$and were associated with increased risk of death from COVID-19 (Table 3).

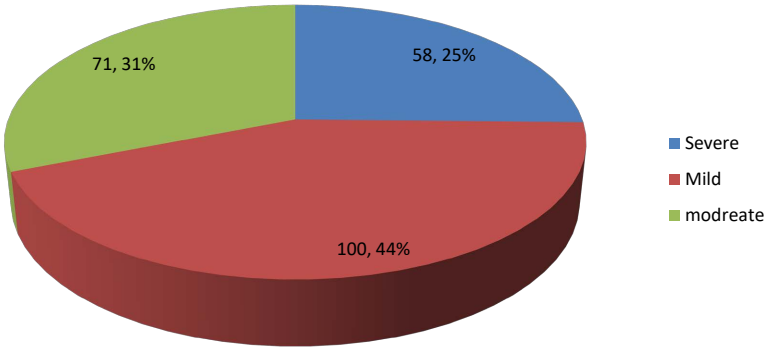

Figure 1. Classification of COVID-19 patients according to severity of disease. n = 229.

Table 3. Clinical presentation and co-morbidities of COVID-19 patients in Kassala state, eastern Sudan.

Variables	Clinical outcome		Total n = 229	*P* value
	Recovered n = 193	Death n = 36		
Clinical presentation				
Fever	182 (94.3%)	33 (91.7%)	215 (93.9%)	0.545
Cough	158 (81.9%)	30 (83.3%)	188 (82.1%)	0.833
Shortness of breathing	123 (63.7%)	31 (86.1%)	154 (67.2%)	0.009
Sore throat	158 (81.9%)	28 (77.8%)	186 (81.2%)	0.564
Headache	151 (78.2%)	28 (77.8%)	179 (78.2%)	0.951
Myalgia	131 (67.9%)	25 (69.4%)	156 (68.1%)	0.853
Runny nose	23 (11.9%)	3 (8.3%)	26 (11.4%)	0.534
Hospital stay	58 (30.1%)	35 (97.2%)	93 (40.6%)	<0.001
Chronic diseases (co-morbidities):				
Diabetes	113 (58.5%)	28 (77.8%)	141 (61.6%)	0.029
Hypertension	8 (4.1%)	5 (13.9%)	13 (5.7%)	0.020
Renal impairment	6 (3.1%)	8 (22.2%)	14 (6.1%)	<0.001
Asthma	17 (8.8%)	4 (11.1%)	21 (9.2%)	<0.001
Epilepsy	9 (4.7%)	3 (8.3%)	12 (5.2%)	<0.001
Tuberculosis	5 (2.6%)	8 (22.2%)	13 (5.7%)	<0.001

Numerous laboratory test results such as Leukocytosis, Lymphopenia, anemia, thrombocytopenia, Prothrombin Time (PT), Partial Thromboplastin Time (PTT), International Normalized Ratio (INR), Erythrocyte Sedimentation Rate (ESR), C-Reactive Protein level (CRP) and serum calcium, were significantly associated with increased risk of COVID-19 infection and high case fatality rate (Table 4).

About 93 (40.6%) cases of confirmed COVID-19 patients had been hospitalized. Out of 229 COVID-19 patients, 51 (22.3%) were admitted to intensive care unit and 42 (18.3%) were admitted to the isolated word. Oxygen therapy was offered to 41 (17.9%) patients and Eleven (4.8%) patients received Mechanical

ventilator (Figure 2). 193 patients recovered and discharge home while, 36 died (Figure 3).

The median length of hospital stay for patients with COVID-19 was 21 days (Table 5).

Table 4. Laboratory tests of COVID-19 patients in Kassala state, eastern Sudan.

Variables	Clinical outcome		Total n = 229	*P* value
	Recovered n = 193	Death n = 36		
Leukocytosis	135 (69.9%)	31 (86.1%)	166 (72.5%)	0.046
Low RBCs	36 (18.7%)	12 (33.35)	48 (21%)	0.047
Low Hemoglobin	75 (38.9%)	21 (58.3%)	96 (41.9%)	0.030
Thrombocytopenia	9 (4.7%)	3 (8.3%)	12 (5.2%)	0.364
Hypocalcaemia	82 (42.5%)	22 (61.1%)	104 (45.4%)	0.039
Elevated ESR	108 (56%)	35 (97.2%)	143 (62.4%)	<0.001
Elevated CRP level	123 (63.7%)	34 (94.4%)	157 (68.6%)	<0.001
Prolonged Prothrombin Time (PT)	66 (34.2%)	24 (66.7%)	90 (39.3%)	<0.001
Prolonged Partial Thromboplastin Time (PTT)	72 (37.3%)	25 (69.4%)	97 (42.4%)	<0.001
Prolonged INR	66 (34.2%)	24 (66.7%)	90 (39.3%)	<0.001
Neutrophilia	165 (85.5%)	33 (91.7%)	198 (86.5%)	0.320
Lymphopenia	186 (96.4%)	34 (94.4%)	220 (96.1%)	0.585
High blood urea	11 (5.7%)	8 (22.2%)	19 (8.3%)	<0.001
High serum creatinine	2 (1%)	4 (11.1%)	6 (2.6%)	<0.001

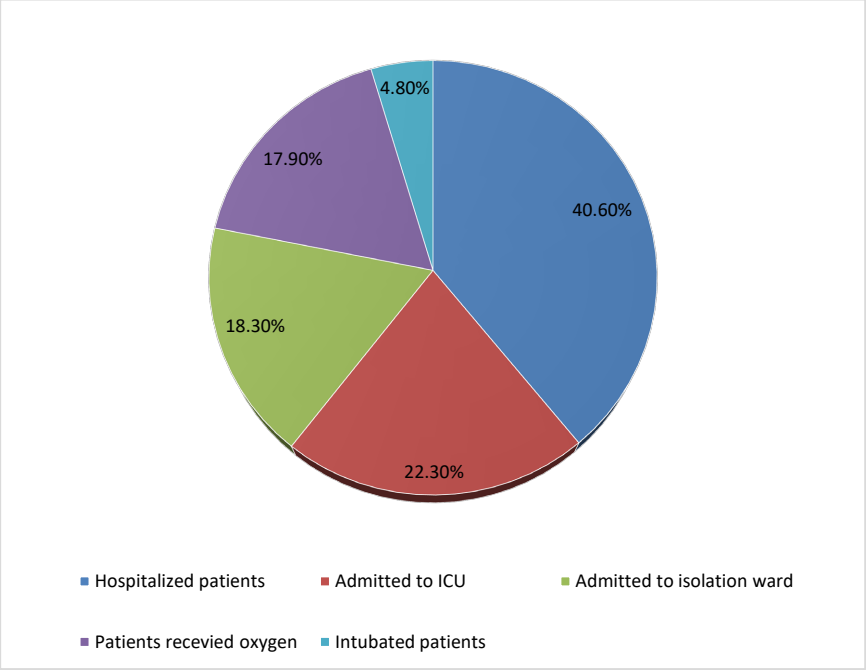

Figure 2. Showing hospital stay status for COVID-19 patients n = 229.

Table 5. Showing the Mean ± Std. Error of Hospital stay duration according to survival outcome of participants.

Hospital stay duration (days)	Recovered			Death			Min	Max
	n	Mean	SEM	n	Mean	SEM		
Hospitalized	58	4.34	± 0.39	35	5.28	± 0.48	3	21
Non-Hospitalized	135	0	0	1	0	0	0	0

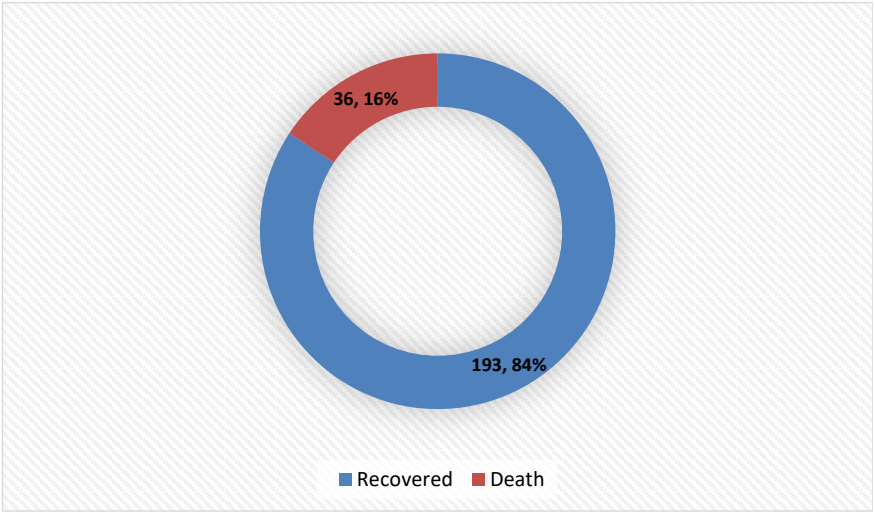

Figure 3. Distribution of case fatality rate among COVID-19 patients in Kassala state, Eastern Sudan. n = 229.

5. Discussion

One of the main findings of this study was that the prevalence of COVID-19 infection estimated as high as 61.7% in comparison with study conducted in neighboring country, Ethiopia [16]. Our data showed that older patients (≥70 years) were significantly associated with COVID-19 infection. Moreover, more than fifty percent of deceased patient were in the age group of ≥70 years (20 individuals 55.6% with P = 0 ≤ 0.001). Previous studies also showed high morbid and mortality among elderly COVID-19 patients [17] [18] [19]. Importantl, older age groups are at a higher risk of developing high case fatality among COVID-19 patients [19] [20]. Also, older age groups have a higher rate of occurrence of comorbid conditions than younger age groups, which may exacerbate fatal outcomes. Male preponderance observed in our setting with male to female ratio of 2.3:1 was comparable to studies carried out in Italy, where the male to female ratio was reported as 2.6:1 [21]. In the present study, the overall mortality rate among COVID-19 patients was 16%, which was comparable to what has been demonstrated by studies conducted in France and the USA, where the case fatality rate was reported as 21.1% and 20.0%, respectively [22] [23]. However, it is higher than the fatality reported in Ethiopia as 6.1% [17].

The discrepancy in mortality rates can be attributed to our study participants' older age, which may lead to more comorbidities and higher case fatality. The

current study also indicated that non modifiable risk factors like being male (77.8% vs. 22.2%) is associated with high fatal outcomes among study participants. These findings align with another study that reported significant differences between males and females with COVID-19 patients [24].

In this study, High mortality among males with COVID-19 may be explained by factors like the fact that women seek healthcare services and pursue Covid-19 testing more frequently than men [25]. Additionally, some authors attribute the existence of high case fatality and severe forms of the disease among men to many risk factors like the high prevalence of coronary artery diseases, genetic predisposition, hormone effects, and non-biological causes like smoking and alcohol consumption [26] [27].

Another report by Solomou *et al.* showed that males exhibit poor compliance with preventive measures to limit the spread of COVID-19, such as social distancing and masking, compared with females [28].

This study revealed that comorbidities like diabetes, hypertension, renal impairment and tuberculosis increased the possibility of death from COVID-19. Similarly, a systematic review showed that comorbidities such as heart disease, hypertension and diabetes enhanced the risk of death among COVID-19 patients [29]. Moreover, a study conducted in Nigeria demonstrated that hypertension, diabetes and renal disease were increased deaths among COVID-19 patients [30]. Therefore, patients with comorbid conditions like diabetes, hypertension, asthma and cardiac diseases should follow all safety measures to avoid COVID-19 infection, as these may worsen their clinical and survival outcomes [31].

This study, showed that shortness of breath was significantly associated with the disease severity and high mortality rates $P = 0.009$. This is in keeping with previous studies that confirmed the shortness of breath as the predictor of death from COVID-19 infection [32] [33].

The majority of study participants were classified as having mild 71 (31%) to moderate 100 (43.7%) COVID-19 infection. However, around one quarter, 58 (25.3%) of our patients reported a severe form of the disease. These findings were in line with the previous study [34].

Although 136 (59.4%) of the study participants were treated as an outpatient, 93 (40.6%) needed hospital admission, of whom 51 (22.3%) were admitted to the intensive care unit and 11 (4.8%) patients received intubation. The incidence of ICU admission of COVID-19 in the present study is similar to Cummings *et al.* report on a New York cohort, in which the incidence of ICU admission was reported as 22% [35]. By contrast, Ombajo *et al.* in Kenya reported the incidence of ICU admission as (11%) among COVID-19 patient. The variability of ICU cases may be related to older age and higher rates of comorbid conditions among study patients [36].

With regards to the severity of the disease, the percentage of the severe patients in the non-survivor arm of the study was significantly higher than in the survivor group (P value < 0.002); this is consistent with the result obtained from

a study conducted in northern Ethiopia [37].

In this study, different laboratory results like leukocytosis, lymphopenia, low Hemoglobin and elevated CRP, were associated with an increased risk of death. These findings are in line with other reports [36] [38].

6. Limitations

The study was conducted in Kassala in eastern Sudan. Therefore, the conclusion of this study can not be applied to all parts of Sudan. Some data were obtained by the review of medical records. While other tests like D-dimer, LDH level, serum Ferritin not included, we have not assessed the impact of Body Mass Index (BMI) in the severity of the disease..

7. Conclusion

This study demonstrated a high case fatality rate among COVID-19 patients in Eastern Sudan, which is equivalent to what has been shown in other studies. Older age, male sex, comorbidities and shortness of breath increase the risk of disease severity and mortality of COVID-19 infection. Therefore, many efforts should be directed toward improving testing capacity and case detection as this may lessen the risk of case fatality, particularly among high-risk groups.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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