Journal of Pioneering Medical Sciences
Received: February 09, 2025 | Accepted: March 03, 2025 | Published: April 05, 2025
Volume 14, Issue 03, Pages 92-104

DOI https://doi.org/10.47310/jpms2025140311

Pattern of COVID-19 During the First Epidemic Versus the Second Epidemic

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Abstract **Background:** COVID-19 pandemic was caused by severe acute respiratory syndrome coronavirus 2 identified in China, in 2019 and reported at least two waves. **Objective:** To compare pattern, severity and the outcome of the first and second waves of COVID-19. **Methods:** This is a cross-sectional retrospective comparative hospital-based study conducted during the period of first and second pandemic waves. The study involved patients aging above 18 years who had COVID-19. We collected the completed data from 385 patients' records out of 1041by using a standardized data collection tool. **Results:** Male were common with a ration of (3:1 versus 3:2) between first and second waves consecutively. More than half of them were within the middle age. Comorbidity was a risk in more than one-third of patients; in which diabetes was the most common comorbidity which was significantly associated with the outcome (p-value = 0.038). Moreover, fever was the most common symptom occurred in (79% versus 79.3%), cough was (70% versus 60%). Results showed the systemic involvement had higher incidence among the second wave, while the pulmonary presentation was higher among the first were (82.3% versus 54%). ICU admission incidence was 54.8% and oxygen required was (50% versus 73.9%). Reinfection were (4% versus 13%). The outcome among first wave showed a higher incidence of recovery (55.6% versus 39.1%), while the death incidence was lower in the first wave (25.8% vs. 40.6%). **Conclusion:** There was a significant variation between first and second epidemic waves, the higher mortality rate of the second wave with dominant severe pulmonary and extra pulmonary manifestation and rapid progression made the second labeled as severe.

Key Words Comorbidity, COVID-19, First Epidemic Wave, Second Epidemic Wave, Sudan

INTRODUCTION

Coronavirus disease 2019 (COVID-19) is a severe acute respiratory infection caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) [1]. First identified in Wuhan, China, COVID-19 was characterized by a diverse clinical profile ranging from asymptomatic cases to severe pneumonia and multi-organ dysfunction. The condition is marked by elevated levels of inflammatory markers such as C-reactive protein (CRP), lactate dehydrogenase (LDH), ferritin, procalcitonin (PCT) and D-dimer [2-4]. Given its rapid spread across continents, the World Health Organization (WHO) declared COVID-19 a pandemic on March 11, 2020 [2], reflecting the widespread and unprecedented global impact of the virus.

A notable feature of SARS-CoV-2 is its ability to mutate, giving rise to new variants with enhanced transmissibility and altered clinical characteristics. This ongoing viral evolution resulted in the emergence of distinct waves of infections. The second wave was driven by these emerging mutant strains, which exhibited faster transmission rates and greater virulence, significantly impacting healthcare systems worldwide. While public health interventions and vaccination

efforts played a crucial role in reducing severe disease outcomes, the emergence of less severe variants resulted primarily from viral mutation and the combined effects of population immunity and improved treatment protocols rather than vaccination alone [5-8].

The first wave of COVID-19 was predominantly associated with the A.23.1 variant, followed by the B.1.1.7, B.1.351 and B.1.617.2 variants, originating from regions such as South Africa and the UK [5]. Conversely, the Delta variant emerged as the dominant strain during the second wave, known for its heightened transmission potential and association with more severe disease manifestations.

In Sudan, the first confirmed COVID-19 case was reported on March 13, 2020, in Khartoum [6]. By the end of August 2020, Sudan had recorded 9,299 cases during the first wave. Following a brief decline, the country witnessed a resurgence of cases in November 2020, signaling the onset of the second wave, during which 707 new cases were reported within a short time frame. Data for both waves were systematically collected and reported to the Sudan Ministry of Health through the national surveillance system [3,9].

This study aims to provide a comprehensive comparison of the clinical patterns, severity and outcomes between the first and second pandemic waves of COVID-19 in Sudan. The investigation follows the WHO criteria and Sudan's national protocol for COVID-19 management while incorporating key metrics such as the NEWS score to assess disease progression and outcomes.

METHODS

Study Design and Setting

This retrospective cross-sectional comparative hospital-based study was conducted during the first and second pandemic waves of COVID-19 in secondary hospitals across River Nile State, Sudan, between April 2020 and June 2021. The study aimed to evaluate the clinical pattern, severity and outcomes of COVID-19 patients during these two waves.

Study Population

The study included all hospitalized patients and those evaluated in the triage during the study period who met the inclusion criteria. The inclusion criteria comprised patients with a positive COVID-19 PCR nasal sample, aged 18 years or older and with complete medical records. The exclusion criteria included patients with incomplete medical records, negative COVID-19 PCR tests and patients younger than 18 years. Individuals who were exactly 18 years old were included in the study.

To account for potential bias introduced by exclusions, we calculated the percentage of excluded records. Among the total 1,041 COVID-19 patient records obtained from local health authorities, a combined 6% of records were excluded due to incomplete data or patients being under 18 years of age. This exclusion rate was consistent across both waves and was unlikely to significantly influence the comparative outcomes.

Sample Size Calculation and Sampling Technique

The sample size was calculated based on a previous similar study, which suggested that 384 patients were required to achieve a 95% precision assuming maximal heterogeneity. From the available records, 341 patients' records were included from the first wave and 700 patients' records from the second wave. A simple random sampling technique with equal probability was employed to ensure unbiased data collection.

Data Collection

Data were extracted from medical records using a structured data collection checklist prepared by the research team. The checklist included demographic information, clinical presentation, laboratory investigations, imaging findings and treatment outcomes.

Investigations

Diagnostic investigations included a PCR nasal sample for COVID-19 confirmation, as well as additional tests such as ESR, CRP, D-dimer, CBC, serum troponin, LDH, INR, renal and liver function tests. Imaging investigations included chest X-ray and CT chest scans to assess pulmonary involvement.

Data Analysis

All collected data were analyzed using the Statistical Package for Social Sciences (SPSS), version 21.0. The incidence and patterns of COVID-19 were determined and risk factor associations were evaluated using the chi-square (χ^2) test. Associations were considered statistically significant if $p<0.05$.

Ethical Considerations

Approval for this research protocol and study template was obtained from the Sudan Medical Council Specialization Board, Ethical and Research Committee (EDC), Ministry of Health in the River Nile State and the administrations of the participating isolation centers. All procedures followed ethical guidelines to ensure the safety and confidentiality of patient information.

RESULTS

We included 384 patients' records with COVID-19. Of them, 124 patients' records represented the first wave, while 261 patients' records regarded as the second wave. In the first wave Males were 90 and females were 34 in the first wave (the ratio 3:1) while the second wave show 146 male and female 97 the ratio (3:2). Smoking was the higher incidence

Table 1: The demographic features of the patients (N = 385)

	First epidemic frequency (%)	Second epidemic frequency (%)
Sex		
Males	90 (72.6%)	146 (60%)
Females	34 (27.4%)	97 (40%)
Age group		
16-26	14 (11.3%)	6 (2.3%)
27-44	15 (12.1%)	20 (7.7%)
45-66	66 (53.2%)	137 (52.5%)
67-79	22 (17.7%)	64 (24.5%)
80-89	6 (4.8%)	33 (12.6%)
>90	1 (0.8%)	1 (0.4%)
Social habits		
Not use	75 (60.5%)	200 (76.6%)
Smoking	28 (22.6%)	39 (14.9%)
Alcohol	5 (4%)	4 (1.5%)
Tobacco	11 (8.9%)	10 (3.8%)
Recreational drugs	1 (0.8%)	0 (0%)
Not documented	4 (3.2%)	8 (3.1%)
Total	124 (100%)	261 (100%)

social habit among both epidemics were22.6% in the first higher in compare to the second which were 14.9% as shown in Table 1.

The distribution of risk factors among the study group revealed notable differences between the first and second waves of COVID-19. Among the participants in the first wave, 50.8% had diabetes, with 21.8% being newly discovered cases. In contrast, the second wave showed a lower proportion of newly diagnosed diabetic cases (9.6%), while the percentage of known diabetic cases was higher in the second wave (36.4%) compared to the first (29%).

Hypertension was also more prevalent in the second wave, affecting 37.5% of patients compared to 25.8% in the first. Among hypertensive patients, the use of angiotensin-converting enzyme inhibitors (ACEIs) was more frequent in the second wave (13.8%) compared to the first (9.7%).

Cardiovascular disease (CVD) was reported in 11.2% of patients in the first wave and 13.8% in the second wave. Within this category, Ischemic Heart Disease (IHD) was noted in 4.8% of first-wave patients and 6.9% in the second wave. Other forms of CVD, including valvular heart disease, hypertensive heart disease, arrhythmia and myocarditis, were documented with relatively minor differences between the two waves.

Lung disease prevalence remained low in both waves. Conditions such as restrictive lung disease, COPD and asthma had slightly higher incidences in the second wave but remained below 5% in both groups.

In terms of immunosuppression, the second wave showed a higher percentage of immunosuppressed patients (37.6%) compared to the first (27.2%). Immunosuppression was attributed to various causes, including long-term use of steroids, chemotherapeutics and HIV infection. Immunosuppression due to drug therapy was documented in 4.2% of patients in the second wave, while no such cases were reported in the first. Immunosuppression linked to infections was minimal in both waves (1.6% in the first and 1.1% in the second). Cases involving autoimmune diseases were rare, reported in 0.8% of both groups.

Chronic illnesses were common in both waves, with an incidence of 24.2% in the first wave and 30.3% in the second. Conditions such as malignancy were reported in small proportions in both waves (1.6% in the first wave and 1.2% in the second).

Overall, the second wave exhibited a higher prevalence of hypertension, immunosuppression and chronic illnesses, while newly diagnosed diabetes cases were more common in the first wave (Table 2).

Fever the most presenting symptom were equal among both epidemics compromise 79% followed by cough were 70% in the first and 60 in the second wave. Whilst dyspnea, headache, altered sensation common in the first were 56.5%, 21%, 17.7 more incidence in compare to the second 20.7%. Sore throat incidence higher in the first epidemic were 29% and myalgia and arthralgia equal in both as shown in Table 3.

Systemic involvement had higher incidence in the second wave in compare to the first (Table 4), second epidemic show (GUS were 25.7%, GIT was 19.2%, CNS were 19.2%, impaired level of consciousness was the most symptom 72.8%, CVS where 25.3% chest tide ness were the most presenting symptom were 54.4%). GUS were 14% symptom of UTI and oliguria was the common presenting symptoms, GIT was 6%, were 19.2, CNS were 8%, impaired level of consciousness was the most symptom was 86.3%, CVS where 12.9% chest tidiness were the most presenting symptom were 81.5%). Whilst symptom of UTI and oliguria is the common presenting symptom, GIT Enteropathy, vomiting, diarrhea were the most, CNS impaired level of consciousness were the most symptom in the both epidemics. Clinical sign showed Respiratory rate higher incidence was range from (<8, or >25) were 33.1% in the first epidemic, 42.5% in the second.

Table 2: The comorbidities and immunosuppression status of the patients (N = 385)

Parameters	Values	First Epidemic	Second Epidemic
Cardio vascular disease	Yes	14 (11.2%)	36 (13.8%)
Type of CVD	IHD	6 (4.8%)	18 (6.9%)
	Valvular	3 (2.4%)	8 (3.1%)
	Hypertensive HD	3 (2.4%)	6 (2.3%)
	Arrhythmia	1 (0.8%)	2 (0.8%)
	Myocarditis	1 (0.8%)	2 (0.8%)
	Normal	110 (88.7%)	225 (86.2%)
Lung disease	Restrictive lung disease	0 (0%)	3 (1.1%)
	COPD	2 (1.6%)	3 (1.1%)
	Asthma	3 (2.4%)	8 (3.1%)
	Other	1 (0.8%)	1 (0.4%)
	No lung disease	118 (95.2%)	246 (94.3%)
Diabetes	Known case	36 (29%)	95 (36.4%)
	Newly discover	27 (21.8%)	25 (9.6%)
	Not diabetic	61 (49.2%)	141 (54%)
Hypertensive	Yes	32 (25.8%)	98 (37.5%)
Air Pollution	Yes	8 (6.5%)	22 (8.4%)
Immunosuppressed	Drug-Induced (Steroids/Chemotherapy)	0 (0%)	11 (4.2%)
	Infection (Including HIV)	2 (1.6%)	3 (1.1%)
	Autoimmune disease	1 (0.8%)	2 (0.8%)
	Chronic illness	30 (24.2%)	79 (30.3%)
	Malignancy	2 (1.6%)	3 (1.2%)
	Immuno-suppressed	35 (27.2%)	98 (37.6%)
	Normal	89 (71.8%)	163 (62.5%)
Total	124 (100%)	261 (100%)	

Table 3: The symptoms of the patients (N = 385)

Parameters	First Epidemic	Second Epidemic
Fever	98 (79%)	207 (79.3%)
Cough	70 (56.5%)	158 (60.5%)
Dyspnoea	70 (56.5%)	54 (20.7%)
Headache	26 (21%)	17 (6.5%)
Altered smell	22 (17.7%)	10 (3.8%)
Altered taste	74 (59.7%)	165 (63.2%)
Arthralgia	40 (32.3%)	109 (41.8%)
Myalgia	41 (33.1%)	109 (41.8%)
Anorexia	65 (52.4%)	108 (41.4%)
Expectoration	17 (13.7%)	172 (65.9%)
Sore throat	36 (29%)	35 (13.4%)
Total	124 (100%)	261 (100%)

Oxygen Saturation of (94-95%) were 35.5% higher incidence in first, whilst <91%, were 34.9% higher incidence in the second epidemic. Temperature of (35.1-36 or 38.1-39) had a higher incidence among both epidemics were 77.8% among second, 60.3% among the first epidemic. Concerning vital signs, systolic blood pressure rang of (111-210) were 58.9% among first wave higher, in compare to the higher rang were (91-100) were38.7% among the second (Table 5). Heart Rate (HR) rang of (40-50 or 91-110) were equal in both 55.6% among the second, in compare to 49.2% among the first. Conscious level impaired in 21.1% among the second wave, whilst 14.5%. consider News score 60.2% were above >7 (high) in compare to the first were 33.9%. Jaundiced were detected in 2.3% in the first epidemic, 1.6% in the second epidemic. Paler detected in 14% for both epidemics. Sign of respiratory distress were presented in 35.6% in second wave in compare to 32% in the first.

Chest abnormality detected abnormal findings in 89.7% in the second with higher incidence in second wave, 64.5% were in the first. Abnormality detected, Crackle was the most in both were exhibit more than one sign 16.9%, in the first Consolidation were 6.5%, Pleural effusion were 0, bronchial breathing was 0.8% and Wheeze were 0.8. in the second Crackle were % 36.4, consolidation was 3.8, pleural effusion was 1.1%, bronchial breathing was 5%, wheeze was 5% pleural effusion were 0.8%.

Laboratory finding represented as complete blood count showed in (Table 6) TWBCs in the first wave 54.0% within normal range (4-11), 25.8% were (11-15), 8.9% were >15, 8.1 were <4 were, whilst 3.2% were not documented, lymphocytes were <15 in 50.8% of the patients. in the second wave 45.2% within normal range (4-11), 34.1% were (11-15), 8.8% were >15, 11.5% were < 4 were, whilst 0.4% were not documented, lymphocytes were <15 in 62.1% of the patients higher in compare to the first. Hb g/d in the first wave 25.8% were <11 g/dl, 60.5% most of the patients were within normal range (11-16) g/d, 4.8% were >16, 3.2% were not done, 5.6% were not documented. Hb in compare to the first wave second show 35.6% were <11 g/dl, 67.5% most of the patients were within normal range (11-16) g/d, 4.6% were >16, 1.1% were not done, 1.1% were not documented, similar in both better documented. Platelet in the first wave 11.3% were <150, 66.9% were within normal rang (150-450), 12.9% were >450, 3.2% were not done, 5.6% were not documented. In compare to the first wave second show 15.7% were <150, 73.9% were within normal range (150-450), 5.4% were > 450, 4.2% were not done, 0.8% were not documented. Inflammatory marker showed, CRP in the first wave 3.2% were 0<5, 58.1% were (5-10) positive level, 14.5% were (10-100), 11.3% were >100, 6.5% were not documented, 6.5% were not done,

Table 4: The clinical signs and findings of the patients (N =385)

Parameters	Values	First Epidemic	Second Epidemic
RR (respiratory rate)	12-20	41 (33.1%)	9 (3.4%)
	9-11	21 (16.9%)	55 (21.1%)
	21-24	21 (16.9%)	85 (32.6%)
	< 8 or >25	41 (33.1%)	111 (42.5%)
	Not documented	0 (0%)	1 (0.4%)
Oxygen Saturation	> 96	39 (31.5%)	45 (17.2%)
	94-95	44 (35.5%)	58 (22.2%)
	92-93	21 (16.9%)	67 (25.7%)
	< 91	20 (16.1%)	91 (34.9%)
Temperature	36.1-38	43 (34.7%)	53 (20.3%)
	35.1-36 Or 38.1-39	76 (61.3%)	203 (77.8%)
	> 39.1	3 (2.4%)	4 (1.5%)
	< 35	2 (1.6%)	1 (0.4%)
Systolic blood pressure	111-210	73 (58.9%)	84 (32.2%)
	101-110	27 (21.8%)	101 (38.7%)
	91-100	2 (1.6%)	16 (6.1%)
	< 90 or > 210	22 (17.7%)	60 (23%)
Heart rate (HR)	51-90	40 (323%)	13 (5%)
	40-50 or 91-110	61 (49.2%)	145 (55.6%)
	111-130	15 (12.1%)	84 (32.2%)
	< 40 or > 131	8 (6.5%)	19 (7.3%)
Conscious level	Conscious	106 (85.5%)	206 (78.9%)
	Impaired conscious	18 (14.5%)	55 (21.1%)
News score	1-4 (low)	53 (42.7%)	33 (12.6%)
	5-6 (medium)	29 (23.4%)	71 (27.2%)
	> 7 (high)	42 (33.9%)	157 (60.2%)
Jaundice	Yes	2 (1.6%)	6 (2.3%)
Paler	Yes	14 (11.3%)	37 (14.2%)
Signs of respiratory distress	Yes	32 (25.8%)	93 (35.6%)
Chest status	Normal	44 (35.5%)	27 (10.3%)
	Abnormal	80 (64.5%)	234 (89.7%)
Abnormality detected	Crackle	21 (16.9%)	95 (36.4%)
	Consolidation	8 (6.5%)	10 (3.8%)
	Pleural effusion	0 (0%)	3 (1.1%)
	Bronchial breathing	1 (0.8%)	13 (5%)
	Wheeze	1 (0.8%)	13 (5%)
	>2 sign	51 (41.1%)	99 (37.9%)
	Other	1 (0.8%)	2 (0.8%)
	Normal chest	41 (33.1%)	26 (10%)
Total	124 (100%)	261 (100%)	

whilst higher result in second wave CRP were 0% <5, 65.9% were (5-10), 28.0% were (10-100), 1.9 were >100, 0.8% were not documented, 3.4% were not donates mm/hr. in first wave 1.6% were (0-20), 31.5% were (21-75), 37.9% were >3 figure, 22.6% were not done, 6.5% were not documented. In compare to the second wave ESR mm/hr. LDH u/l, 1.6% were (122-222), 4.8% were >2 figure, 10.5% % were >3 figures, 81.5% were not done, 1.6% were not documented, in compare to the second LDH u/l, .8% were (122-222), 4.2% were >2 figure, 22.2% were >3 figures, 72.4% were not done, 0.4% were not documented. D. dimer in the, 3.2% were <500, 8.1% were (500-5000), 12.1% were >5000, 76.6% were not done, 0% were not documented, whilst D. dimer in the second epidemic, 0.8% were <500, 7.3% were (500-5000), 24.5 were >5000, 67% were not done, 0.4% were not documented. Serum ferritin level was not involved as it was applied for three anemic patients. Renal function test results showed, Among the first wave S. urea were <5, were (5-20), were (20-59), were >60, were not documented, were not done. Creatinine mg/dl 10% were <0.7, 24.2% were (0.7-1.3), 8.9% were (1.4-2), 8.1% were >2, 4.8% were not documented and 43.5% were not done. In compare to the second wave S. Urea 10% were <5, 46% were (5-20), 20.7% were (20-59), 10.7% were >60, 1.5% were not documented, 11.1% were not done. S. Creatinine mg/dl 16.5% were <0.7, 39.8% were (0.7-1.3), 20.7% were 1.4-2), 11.1% were >2, 2.3% were not documented, 9.6% were not done. Random Blood Sugar result showed mg/dl in the first wave 6.5% were less than 70, 30.6% were rang (70-110), 25.8% were rang (111-179), 30.6% were >180, 1.6% not documented, 4.8% were not done. In the second wave 5% were less than 70, 34.9% were rang (70-110), 19.5% were rang (111-179), 33.7 were >180, 0% not documented, 6.9% were not don. ICT and peripheral film result of co-existence falciparum malaria results were positive 9.7%, 16.9% were negative, in 59.7% were not done and 13.7 were not documented. In the second wave result were positive 10%, 14.2% were negative, in 46.4% were not done and 29.5% were not documented. Concerned images in

Table 5: The laboratories and radiological findings of the patients (N = 385)

Parameters	Values	First Epidemic	Second Epidemic
TWBCS	< 4	10 (8.1%)	30 (11.5%)
	04-Nov	67 (54%)	118 (45.2%)
	Nov-15	32 (25.8%)	89 (34.1%)
	>15	11 (8.9%)	23 (8.8%)
	Not done	4 (3.2%)	1 (0.4%)
Lymphocyte %	< 15	63 (50.8%)	162 (62.1%)
	16-44	53 (42.7%)	89 (34.1%)
	> 45	2 (1.6%)	4 (1.5%)
	Not done	3 (2.4%)	1 (0.4%)
	Not documented	3 (2.4%)	5 (1.9%)
Hb % g/dL	11 g/dl	32 (25.8%)	93 (35.6%)
	11-16 g/dl	75 (60.5%)	150 (57.5%)
	>16	6 (4.8%)	12 (4.6%)
	Not done	4 (3.2%)	3 (1.1%)
	Not documented	7 (5.6%)	3 (1.1%)
	<150	14 (11.3%)	41 (15.7%)
Platelets	150-450	83 (66.9%)	193 (73.9%)
	> 450	16 (12.9%)	14 (5.4%)
	Not done	4 (3.2%)	11 (4.2%)
	Not documented	7 (5.6%)	2 (0.8%)
CRP	0< 5	4 (3.2%)	0 (0%)
	(5-10) positive	72 (58.1%)	172 (65.9%)
	10-100	18 (14.5%)	73 (28%)
	>100	14 (11.3%)	5 (1.9%)
	Not documented	8 (6.5%)	2 (0.8%)
	Not done	8 (6.5%)	9 (3.4%)
ESR	0-20	2 (1.6%)	0 (0%)
	21-75	39 (31.5%)	55 (21.1%)
	>3 figures	47 (37.9%)	157 (60.2%)
	Not done	28 (22.6%)	13 (5%)
	Not documented	8 (6.5%)	36 (13.8%)
LDH u/l	122-222	2 (1.6%)	2 (0.8%)
	>2 figures	6 (4.8%)	11 (4.2%)
	>3 figures	13 (10.5%)	58 (22.2%)
	Not done	101 (81.5%)	189 (72.4%)
	Not documented	2 (1.6%)	1 (0.4%)
D. dimer	<500	4 (3.2%)	2 (0.8%)
	500 – 5000	10 (8.1%)	19 (7.3%)
	>5000	15 (12.1%)	64 (24.5%)
	Not done	95 (76.6%)	175 (67%)
	Not documented	0 (0%)	1 (0.4%)
S. urea mg/dL	<5	4 (3.2%)	26 (10%)
	May-20	29 (23.4%)	120 (46%)
	20-59	14 (11.3%)	54 (20.7%)
	> 60	11 (8.9%)	28 (10.7%)
	Not documented	7 (5.6%)	4 (1.5%)
	Not done	59 (47.6%)	29 (11.1%)
Creatinine mg/dL	<0.7	13 (10.5%)	43 (16.5%)
	0.7-1.3	30 (24.2%)	104 (39.8%)
	1.4-2	11 (8.9%)	54 (20.7%)
	> 2	10 (8.1%)	29 (11.1%)
	Not documented	6 (4.8%)	6 (2.3%)
	Not done	54 (43.5%)	25 (9.6%)
RBS mg/dL	Less than 70	8 (6.5%)	13 (5%)
	70-110	38 (30.6%)	91 (34.9%)
	111-179	32 (25.8%)	51 (19.5%)
	> 180	38 (30.6%)	88 (33.7%)
	Not documented	2 (1.6%)	0 (0%)
	Not done	6 (4.8%)	18 (6.9%)
Rapid nasal test	Positive	46 (37.1%)	115 (44.1%)
	Negative	16 (12.9%)	36 (13.8%)
	Not done	62 (50%)	110 (42.1%)
PCR nasal test	Positive	104 (83.9%)	210 (80.5%)
	Not done	20 (16.1%)	51 (19.5%)
CT SCAN	Normal	16.12 (13%)	8.091 (3.1%)
	Abnormal	43.4 (35%)	104.4 (40%)
	Not Done	63.24 (51%)	148.509 (56.9%)
Chest X-RAY	Normal	43.028 (34.7%)	44.892 (17.2%)
	Abnormal	80.972 (65.3%)	216.108 (82.8%)
Total		124 (100%)	261 (100%)

Table 6: Association of WHO evaluation and the outcome of the patients (N = 385)

WHO score	Complete recovery	Premature discharge+Escape	Disability	Death	Total	p-value
First epidemic						
>5	41 (47.7%)	15 (17.4%)	3 (3.5%)	27 (31.4%)	86 (100%)	0.058
<5	28 (73.7%)	4 (10.5%)	1 (2.6%)	5 (13.2%)	38 (100%)	
Total	55.6%	19 (15.3%)	4 (3.2%)	32 (25.8%)	124 (100%)	
Second epidemic						
>5	65 (36.9%)	22 (12.5%)	18 (10.2%)	71 (40.3%)	176 (100%)	0.626
<5	37 (44%)	9 (10.7%)	4 (4.8%)	34 (40.5%)	84 (100%)	
Not applicable	0.0%	0.0%	0.0%	1 (100%)	1 (100%)	
Total	102 (39.1%)	31 (11.9%)	22 (8.4%)	106 (40.6%)	261 (100%)	

Table 7: The pulmonary, extrapulmonary presentation and outcome of the patients (N = 385)

Parameters	Values	First Epidemic	Second Epidemic
Presentation	Pulmonary	102 (82.3%)	141 (54%)
	Extra pulmonary	4 (3.2%)	17 (6.5%)
	Both	18 (14.5%)	103 (39.5%)
Pattern of pulmonary presentation	Asymptomatic	1 (0.8%)	4 (1.5%)
	Common cold	28 (22.6%)	16 (6.1%)
	Moderate pneumonia	46 (37.1%)	68 (26.1%)
	Severe pneumonia	37 (29.8%)	115 (44.1%)
	PE	1 (0.8%)	5 (1.9%)
	ARDS	8 (6.5%)	37 (14.2%)
	Not applicable	3 (2.4%)	16 (6.1%)
Extra pulmonary	GIS (Enteropathy, pain, etc.)	5 (4%)	31 (11.9%)
	CNS (Stroke, coma, etc.)	1 (0.8%)	36 (13.8%)
	CVS (MI, carditis, etc.)	3 (2.4%)	25 (9.6%)
	GUS (UTI, AKI, etc.)	12 (9.7%)	45 (17.2%)
	Other	1 (0.8%)	0 (0%)
	Normal	102 (82.3%)	124 (47.5%)
Sepsis and multi organ failure	Yes	12 (9.7%)	74 (28.4%)
	No	112 (90.3%)	187 (71.6%)
Patents' outcome	Complete recovery	69 (55.6%)	102 (39.1%)
	Premature discharge, escape	19 (15.3%)	31 (11.9%)
	Disability	4 (3.2%)	22 (8.4%)
	Death	32 (25.8%)	106 (40.6%)
Total		124 (1%)	261 (1%)

the first CT. Scan in 124 patients were abnormal in 35%, normal in 13%, but not done among 51% of population among the wave, whilst among the second chest CT. Scan in 261 patients, in 56% were not done, 40% were abnormal, 3.1% were normal and 0.4% were not documented. whilst chest x-ray Abnormality was detected among 82.8% in the second with higher incidence than the first, which were 65.3%. COVID-19 specific test results in the first epidemic Rapid nasal test (10-15 min) rapid chromatographic specific Ag immunoassay 37.1% Positive, 50% not done, 12.9% Negative, compare to second epidemic Rapid nasal test had higher Positive incidence were 44.1%, 42% were not done, 13.8% Negative, whilst PCR in the first epidemic positive (positive more than 100 copies) incidence were 83.9%, not done in 16.1%, compare to the second 80.5% positive,19 .5% were not done as illustrated in (Table 7).

According to clinical presentation, in the first 82.3% were pulmonary, 3.2% were extra-pulmonary, 14.5 show both, between second epidemic 54% were pulmonary, 6.5% extra-pulmonary, 39.5 show both, with higher incidence. Pulmonary presentation in the first epidemic 0.8% were asymptomatic, 22.6% were presented as common cold, 37.1% were moderate pneumonia, 29.8% Severe pneumonia, 0.8% were Pulmonary Embolism, 6.5% were ARDS, 2.4 were extra pulmonary, In the second epidemic 1.5% were asymptomatic, 6.1% were presented as common cold, 26.1% were moderate pneumonia, 44.1% Severe pneumonia, 1.9% were Pulmonary Embolism, 14.2% were ARDS, 6.1 were extra pulmonary. extra pulmonary presentation IN the first epidemic 4% were GIS (Enteropathy, pain..., etc.), 0.8% were CNS (Stroke, coma, etc.), 2.4% were CVS (MI, carditis, etc.), 9.7% GUS (UTI, AKI, etc.), 0.8% were Other, whilst 82.3% were Normal. IN the second epidemic 31% were GIS (Enteropathy, pain..., etc.), 13.8% were CNS (Stroke, coma, etc.), 9.6% were CVS (MI, carditis, etc.), 17.2% GUS (UTI, AKI, etc.), 0% were Other, whilst 47.5% were Normal. Concern sepsis and multiorgan failure in the first epidemic sepsis and multi organ incidence were 9.7%, less compare to incidence in the second were 28.4%. First epidemic show higher incidence of recovery 55.6% may be due to hospitalization rates, admission and isolation for all individuals with virus-positive reports, which changed to encouraged home-based isolation and admission for sicker patients. While lower death incidence was 25.8%. In compare to the second show low recovery incidence were 39.1 and higher death incidence 40.6% as shown in (Table 5).

Table 8: Association of News Score evaluation and the outcome of the patients (N = 385)

News score	Complete recovery	Premature discharge+Escape	Disability	Death	Total	p-value
First epidemic						
1-4 (low)	42 (79.2%)	6 (11.3%)	2 (3.8%)	3 (5.7%)	53 (100%)	<0.001
5-6 (medium)	14 (48.3%)	7 (24.1%)	1 (3.4%)	7 (24.1%)	29 (100%)	
≥ 7 (high)	13 (31%)	6 (14.3%)	1 (2.4%)	22 (52.4%)	42 (100%)	
Total	69 (55.6%)	19 (15.3%)	4 (3.2%)	32 (25.8%)	124 (100%)	
Second epidemic						
1-4 (low)	27 (81.8%)	3 (9.1%)	0 (0.0%)	3 (9.1%)	33 (100%)	<0.001
5-6 (medium)	45 (63.4%)	9 (12.7%)	2 (2.8%)	15 (21.1%)	71 (100%)	
≥ 7 (high)	30 (19.1%)	19 (12.1%)	20 (12.7%)	88 (56.1%)	157 (100%)	
Total	102 (39.1%)	31 (11.9%)	22 (8.4%)	106 (40.6%)	261 (100%)	

Both epidemics show strong association between news score and outcome as strongly significant p-value of <0.001 (significant p-value (0.05). Plan of management using NEWS score system (News score in the second were 60.2% were above >7 (high) in compare to the first were 33.9%) and classification of pneumonia according to CURB 65 In the first epidemic the incidence if general word admission were higher which were 54%, whilst the ICU admission higher among the second which were 54.8% in favor rapid progression and severity among the second wave as shown in (Table 8).

Susceptibility of COVID-19 using WHO suspected score: both epidemics (first, second) distributed around the mean with 1.35 incidence were 69.4%, 67.4% were >5 score consecutively. The association between WHO score system and patients outcome showed insignificant statistical associations (more than 0.05) as shown in (Table 6).

DISCUSSION

River Nile state had witnessed the first wave of COVID-19 in 2020, which peaked in July 2020 and gradually the cases declined. Again, in December 2020, new progression of cases noticed infections with the new virus variant appeared on January to tick up and over the next 6 months. According to experts, the official death toll is even higher than what the official data suggest. This retrospective study had done to assess pattern severity and outcome among the river Nile population during the first vs the second wave of SARS-CoV-2 infections between April-October 2020, December 2020_June 2021 from River Nile hospitals and COVID-19 centers [10-20].

In this study, in both epidemics of COVID-19, we had a higher proportion of male cases compared to females. Our results represent a slightly higher proportion of male cases among the first wave, where males were the most affected [21]. In contrast to our findings other studies conducted in the United Kingdom that showed that women were twice more likely to get COVID-19 [22] and the mean age was middle age a (45-66) for both, as has been reported elsewhere study in China where it was found that most of the affected persons were aged 50-55 years old, [23,24]. IN contrast to African study in Uganda young people aged 19 to 39 years were more affected (33) however we found that the virus was affecting all age groups. In our current study we found that the majority of the cases reported having several and varying symptoms during the course of the disease where most of them reported Fever the most presenting symptom were equal among both epidemics followed by, cough, whilst dyspnea, headache, altered sensation and Sore throat were common among the first wave in compare to the second and myalgia and arthralgia were equal in both agreement with previously reported [25].

In Sudan a retrospective descriptive study, COVID-19 cases records obtained from the national surveillance line-list in Surveillance and Information Directorate in Federal Ministry of Health Sudan [26]. Common symptoms among symptomatic patients were; fever (26.4%), cough (19.1%), shortness of breath (16.8%) with small proportion (4.5%) reported loss of smell and taste. Specific states, Khartoum, Gezira and Red Sea showed highest prevalence (22). Based on the report of the first 425 confirmed cases in Wuhan, the common symptoms include fever, dry cough, myalgia and fatigue with less common are sputum production, headache, hemoptysis, abdominal pain and diarrhea [27]. We further observed married were in the first epidemic higher compare to the second waves, poor documentation and free movement may explain this. Too Such discrepancies in studies could be explained by the fact that there is previously documented high care-seeking behavior exhibited by married than unmarried (32). Potentially social roles in families and communities. We also report Susceptibility of COVID-19 using WHO suspected score: both epidemics mostly were >5 score which support included criteria in the WHO Covid scoring system. Systemic involvement had higher incidence in the second wave in compare to the first, second epidemic show GUS, GIT and CNS were the most affected system. For CNS impaired level of consciousness was the most presenting symptom and chest tide ness Enteropathy, vomiting, diarrhea and oliguria were the most presenting symptoms for each system [28].

Noticed kidney status among the study showed that normal kidney patients in compare to CKD and ESRD were get the infection but as a risk factor as showed severe disease and mortality, whilst the study showed incidence of AKI higher among second as presentation.

The mode of transmission among both epidemics were un known near in the first compare to the second contact incidence was higher among the first epidemics, whilst community transmission among the second were the most in favors the rapid distribution and may explain asymptomatic, subclinical, poor notification and stigma among communities. In compare to Data from 43,338, COVID-19 patients in England from March-end to May 2021 and found that more COVID-19 patients with second pandemic was hospitalized during this period than first epidemics patients [16]. interventions and vaccinations that, unfortunately, has not been the case in other areas. Individuals of all ages are at risk for infection and severe disease. However, the probability of serious COVID-19 disease is higher in people aged ≥60 years, those living in a nursing home or long-term care facility and those with chronic medical conditions. Health worker showed higher incidence among the first in compared to the second [22].

Concerning mortalities and comorbidities the most common risk factor were diabetes, hypertension and CVD, with higher incidence among the second epidemic perhaps poor knowledge earlier affect documentation. Similar as Indian, comparative cohort study between first vs second attack were done showed majority were men and 20% less than 40 years. Prevalence of hypertension, diabetes and cardiovascular diseases were more than 20% [20]. Less common risk factors were Smoking, lung disease, surgery, Air pollution, immune suppression and chronic illness was common risk factors with a little bet variation among both epidemics, this observation is surprising and may explain the increased numbers of severe cases and hospitalizations observed and reported in the second versus the first or and explain insensible surge of comorbidities among community. The study showed the second epidemics more severe than the first Compared to our results findings, inverse results Lesser disease severity and lower hospitalizations from the second wave have been reported in UK and USA in vaccinated individuals. (15)(16) may explained vaccination and good health system, awareness messages, social gatherings and distances which less in our state in compare to developed countries. study notice a need to strength infection prevention and control (IPC) measures to mitigate health facility-acquired IPC guidelines and outbreak strategies including modifiable risk factors and aggressive role back and control of comorbid surging diseases.

One more critical area of concern identified during our study observed Clinical sign showed higher incidence of respiratory rate higher incidence and Oxygen Saturation was in the first epidemic seemed to be more compensated may explain low progression , well compensation or other hidden reason extend behind, whilst the second show lower respiratory rate, higher incidence impaired level, of Consciousness and less Oxygen Saturation explain rapid progression, severity and poor compensation. 38°C Temperature showed a higher incidence among both epidemics. Concerning vital sign study showed, systolic blood pressure higher reading among the first wave, in compare to the lower reading among the second may in favor severity too.

Whilst Heart rate (HR) were equal among both epidemics, consider News score showed higher score incidence above >7 in compare to the first epidemics strongly support the severity of the second epidemics accompany with abet higher incidence of Sign of respiratory distress among the second wave need to strength ICU system hope to decrease mortality as shown in developed countries inversely study on Scotland population-based study reported double rate of hospitalization from the virus, United States between January and May 2020, 14% of patients required hospitalization, 2% were admitted to the intensive care unit and 5% died [16]. Low ICU hospitalization indicate low NEWS score.

The study showed Chest abnormality detected with higher incidence among the second wave, whilst Crackle was the most Abnormality detected among both epidemics, however were exhibit more than one sign for others such as Consolidation, bronchial breathing, Wheeze etc. laboratory finding in this study represented as complete blood count showed leukocytosis and lymphopenia were more detected in severe ill patients a bit higher in second wave compare to the first in favor severity among the second wave. Whilst most of patient within normal range hemoglobin level, anemias were noticed to be higher in the second wave [29-35]. Platelet in both most patient were within normal range, in the first wave, thrombocytosis noticed to be higher among the first in compare to thrombocytopenia among the second wave documented. In compare to Indian study, lymphopenia was the most common lab parameter in both the wave). Similar as seen in this study lymphocytosis and thrombocytopenia were more prevalent during the second wave. Lymphopenia at presentation was reported as one of the reasons for poorer prognosis in COVID-19 consistwith of the Korean studies [36]. Another meta-analysis reported that leukocytosis was more prevalent in non-survivors of COVID-19 with a weighted mean difference of 3.66 [95%, CI (2.58-4.74)]. Another meta-analysis also found that patients who had thrombocytopenia, raised alanine aminotransferase (ALT) and raised creatinine were associated with higher mortality [10]. In our study, lymphocytosis, thrombocytopenia and raised aspartate transaminase (AST) were more prevalent during the second wave and which was statistically significant. As per one of the meta-analyses, thrombocytopenia increases the risk of severe COVID-19 by over five folds [20]. In another meta-analysis, they found that the patients who had severe anemia had more severe disease with a weighted mean difference (WMD)-4.08 [95%, CI (5.12-3.05)]. In this study also, anemia was present in almost 28% of the patients.

Inflammatory marker showed, CRP was a bit higher in second but it limited as the most of the first wave patient titer was not done, similar limitation may bias the result as higher incidence of higher range result showed among the second as it was less requested among the first wave, similar as LDH u/l higher result among second wave and too D. dimer in the, serum ferritin level was not involved as it was applied for three anemic patients. Renal function test results showed, a bit higher result Among the second wave as acute kidney injury showed higher rate in compare to the first. Whilst, Random Blood Sugar result showed a bit similarity with noticeable high reading among third of both epidemics patients.

Specific test ICT and peripheral film result of co-existence falciparum malaria result epidemiology was semi-equal apart of that positive result among the second were noticed among severe ill patient and those with multiorgan failure may in favor it as accelerating factor further study needed to support or reject.

Images showed CT abnormalities in the majority of both epidemic with more destruction and grass ground appearance to non-specific feature were noticed in the periphery and bilateral affected more than unilateral among both, whilst x-ray non seen more among the second wave.

COVID-19 specific test results rapid chromatographic specific Ag immunoassay had been introduced late hence not applied for all among the first, however it was higher positive result among the second, whilst false negative result detected among both which confirmed later with, PCR application that made PCR among the first epidemic had higher positive incidence, as it was less used among the second as positive rapid test were used to confirm instead.

According to clinical presentation pattern, in the first pulmonary manifestation were common in more than two third of the patients, whilst both presentation pattern between second pulmonary and extra-pulmonary pattern of presentation was common among the second epidemic. Asymptomatic detected patients were equal in both, among the first higher incidence rate presented as common cold in compare to the second severe pneumonia and ARDS incidence rate were higher among the second which enforce that the second wave were more severe. extra pulmonary presentation pattern showed enteropathy, renal and neurological involvement as common extrapulmonary to less extend cardiovascular manifestation. Concern sepsis and multiorgan failure in the first epidemic sepsis and multi organ incidence were less compare to incidence in the second supporting different pattern, virulence and severity. About 60.2% were above >7 (high) in compare to the first were 33.9%) and classification of plan of management using NEWS score system (News score in the second were pneumonia according to CURB 65 In the first epidemic the incidence if general word admission were higher which were 54%, whilst the ICU admission higher among the second which were 54.8% in favor rapid progression and severity among the second wave [37]. Duration of admission was variable During the first wave almost of the patient admitted 2 weeks which were 48%, whilst a week which were 43% in the second regard less of the outcome which in favor rapid progression of disease and severity as it was the duration of death for the most (Figure 11). Rapid spread and progression of the second wave had caused patients to come to the hospital in more distressing conditions and needed more aggressive management and Intensive Care Unit (ICU) care [21]. Most of the patients during the second wave had tachypnea and hypoxia at presentation. Also, most patients needed ICU stay and NIV support during the hospital stay. In contrast to the first wave, fewer patients underwent renal replacement therapy during the second wave. This may be attributed to the rapid progression of the disease and short hospital stays [4].

ARDS remains the leading cause of death in the COVID-19 patients, as seen in multiple studies and meta-analyses including this present study [10]. As ICU admission were higher among the second wave. The ARDS remains the leading cause of death as seen in multiple studies [38]. Oxygen requirement was less among the first epidemic may justify compulsive and late home isolation decision, admission during the first attack regard less of indication. Regarding vaccination during were less in compare to the seconds as social stigma (concern complication), availability were the possible causes among the first were the second availability for comorbidity and travelling purpose and poor documentation were the possible causes. Reinfection rate in the First epidemic 4 patients were re-infected, whilst 13 patients were re-infected in the second epidemics.

Outcome among the First epidemic showed higher incidence of recovery. May be due to hospitalization rates, admission and isolation for all individuals with virus-positive reports, which changed to encouraged home-based isolation and admission for sicker patients. while lower death incidence. In compare to the second show low recovery incidence were and higher death incidence. As ICU admission were higher among the second wave. ARDS remains the leading cause of death as seen in multiple studies [38]. Patients in the first epidemic whilst poor guidance in early disease supportive treatment simple vitamin inform of VC, D 1000 and zink 50 mg. Antibiotics mostly cefuroxime in dose of 1500 mg, ceftorixone 1-2 g od, combined to meropenem, Fortum, metronidazole, in severe illness, were the most used antibiotics, using intravenous fluids and nasal-cannula based oxygen supplementation as needed and fluid status and electrolytes, antiviral not used, no documented data for plasma and ventilation. Introduce vitamins, simple antibiotic, as the most are admitted for ICU using intravenous fluids and nasal-cannula based oxygen supplementation as needed

solation issues, received injectable antibiotic, steroid introduced lately about, anticoagulant, oxygen and nebulized were, 2 pateint were documented as ventilated. Whilst the second guideline develop well so higher incidence for proved supportive management were showed in the second wave in compare to the first epidemics.

The study showed significant association between immune suppression and outcome with strong significant p-value of 0.014 second epidemic less significant level in compare to the first for association between immune suppression and outcome were p-value 0.08. Support the more virulent generation among the second and support severity. The association between anti hypertensive and outcome namely ACEI showed significant association among the first wave p-value was 0.039 (significant level (0.05), in compare to the second wave. Whilst Association between diabetes and outcome among study group showed that diabetes had significant association with outcome evident by significant p-value of among both epidemics. In contrast to the other no association between bad habit and effect in outcome showed among study group. Whilst previous studies showed association between coexistence of lung pathology and COVID-19 less, low prevalence, or poor documented past medical history of previous lung pathology made it less likely to be associated severity factor.

Higher incidence of lymphopenia, CRP, ESR, LDH and D. dimer were seen in the second epidemic in India similar to this study, comparative cohort study between first vs second attack were done showed majority were men and 20% less than 40 years.

Prevalence of hypertension, diabetes and cardiovascular diseases were more than 20%. Second wave patients had similar pre-hospitalization symptom duration but had significantly greater cough, fever and shortness of breath and lower S Po 2 at presentation with greater lymphopenia, C-reactive proteins, interleukin-6, ferritin, lactic dehydrogenase and transaminases. The second wave patients had a higher incidence of inquiring supplementary oxygen), in the second wave, more patients had evidence of biomarker abnormalities and oxygen and ventilatory. support, although duration of hospitalization was shorter.

In the River Nile State the second wave, showed predominantly delta variant of SARS-CoV-2 19 as local health documentation in compare to alpha variant among the first. In contrast modelling studies predicted lower mortality from the delta variant compared to alpha [35]. Greater mortality was reported in the second vs first mortality rates were lower than the rates of 20-30% reported from New York (USA) [37] and Lombardy (Italy) [38] in first wave of COVID-19. A registry of 4645 patients from Rajasthan state reported mortality rate of 7.3% in the first wave, 45 which is lower than the present study. At the time of the study and during the end of first wave and the start of the second wave COVID-19 vaccine access was extremely very low and only 4% of the studied COVID-19 cases had received two doses of Astra Zeneca vaccine. At the national level, only less than 2% of the targeted population had received two doses of the vaccine [38]. In the River Nile State vaccination restricted to comorbid patient and travelling purpose. Earlier vaccination was AstraZeneca and Pfizer introduced later. Hence, the biggest percentage of the population remained vulnerable to SARS-CoV-2 infections and associated severe disease outcomes, especially among the elderly and those with comorbidities. Low vaccination coverage together with the emergence of COVID-19 variants could have contributed to the high numbers of COVID-19 cases and associated mortalities registered in June 2021 alongside other factors already described in this study. Our study differed from other studies including the one conducted in the United States which showed that COVID-19 vaccination was up to 57%, with the majority of them at least receiving a single dose of vaccination during the same period of this study vaccination status in the second wave patients were poorly documented, apart of vaccine penetration [38-39].

This study had used hospital-based data to assess disease pattern, severity and outcome and patient's records mortality. out come in our study, as compared to previous local, national and international studies, In a vast country with variation. prevalence in reporting of, outcome including mortality, this may not be the best strategy, as many serious patients may not have access to advanced hospital care so as the social stigma too, estimation comorbidity and missed data in the patient's records leading to substantial underestimation of deaths. The best method to overcome this is availability of appropriate multidisciplinary team intervention, social awareness and full documented records. Similar result elsewhere as social media misinformation and falsifications that circulated widely about COVID-19 that affected many of the instituted prevention measures as also reported elsewhere [37].

Study Limitation

We have used hospital-based data to assess disease severity and outcome and patient's records mortality.

In a vast country with variation prevalence in reporting of, outcome including mortality, this may not be the best strategy, as many serious patients may not have access to advanced hospital care, estimation comorbidity and missed data in the patient's records leading to substantial underestimation of deaths. The best method to overcome this limitation is availability of appropriate multi disciplinary team intervention and full documented records.

Lack of documented record detailed data on the causes of deaths, a part of vaccination which had been reported in seven patients records for second wave whilst absent in the first.

Serious challenge to controlling the COVID-19 pandemic. Effectively responding to this formidable variant, will require an evidence-based response including strict implementation of non-pharmaceutical methods.

CONCLUSION

The COVID-19 first and second pandemic is clearly an international public health problem and research area as the ability of the virus to generate new variant.

COVID-19 version can exhibit different systemic effect as it's involve the kidney and presented as AK I in the second wave in compare to the first waves.

The study described observed result, but the findings correlated with the most of the systemic reviews and meta-analysis.

There have been rapid advances in what we know about the pathogen، how it infects cells and causes disease، and clinical characteristics of disease. Important variation among both epidemic pattern, severity and outcome.

The study had showed that most of the baseline demographic and clinical parameters which are attributed with the COVID-19 severity were more common during the second wave and can be one of the possible scientific explanations for the high mortality during the second wave in the river Nile state.

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