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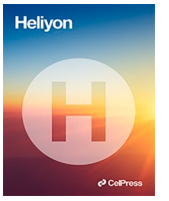

Research article

COVID-19 surveillance report for Sudan, 2020 to 2021

Ahmad Izzoddeen [a], Sabir Abosror [a], Mustafa Magbol [b,*], Alaa Khalil [a], Mazza Abasher [c], Omer Albadri [c], Hafsa Abualgasim Osman [c], Esmail Esmail Mohamed [c], Abdalla Abdalla Mohamed [c], Suleiman Gamal Elgurashi [c], Muntasir M. Osman [c], Tehani Amin [c], Elfadil Mohamed [c], Babiker Magboul [d], Abdalla Siedahmed [e], Elfatih M. Malik [f]

[a] *FETP, FMoH, Sudan*
[b] *Alzaiem Alazhari University, Faculty of Medicine, Khartoum, Sudan*
[c] *HEEC, FMoH, Sudan*
[d] *WHO, Sudan*
[e] *Public Health Centre, Sudan*
[f] *University of Khartoum, Faculty of Medicine, Khartoum, Sudan*

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ABSTRACT

Background: Following the World Health Organization declaration, COVID-19 was first appearance in Sudan was in March 2020. Cases were reported to the Sudan Federal Ministry of Heath through the surveillance system from different sources. This study used surveillance data from 2020 to 2021 to describe the epidemiologic patterns of COVID-19 occurrence in Sudan and provide insight for better preparedness and response.

Methods: Through a retrospective descriptive study, COVID19 cases records obtained from the national surveillance line-list in Surveillance and Information Directorate in Federal Ministry of Health. The analysis of data was done with SPSS version 21. Descriptive analysis done by frequencies and percentages, and further analysis through performing multivariate logistic regression.

Results: Out of 48,545 suspected cases tested for COVID-19 using RT-PCR, 27,453 (56.5%) tested positive with case fatality ratio of 6.5%. Higher death rate among elderly (78% > 60-year-old) and males (70.1%). From the reported cases, 53.8% showed no symptoms, while the 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. The disease peaked four times during 2020–2021, with a proposed alert threshold of 200–250 cases per week acting as an explosion point nationwide.

Conclusions: The high case fatality rate in the country requires further analysis, as well as the high proportion of asymptomatic infection. This will be ensured by improving the quality and completeness of surveillance data. A proposed threshold of 200–250 cases per week should be an alert to augment the measures of controlling the pandemic over the country, including providing enough supplies to decrease mortality.

* Corresponding author. Faculty of Medicine, University of Alzaiem Alazhari, Khartoum, Sudan.
E-mail address: mustafaaltyeb01236009@gmail.com (M. Magbol).

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1. Introduction

The declaration of the novel corona virus disease of 2019 (COVID19) as a pandemic was in March 2020 [1]. At the end of the same year of declaration, the affected people reached 81.2 million with 1.77 million reported death [2]. The transmission of the virus is mainly through respiratory droplets, therefore coming in close contact with infected persons is key in contracting the infection [3]. The patient may present with a wide range of clinical features, starting from fever plus mild respiratory symptoms, to more critical condition with respiratory distress [4]. The frequently seen presentations are fever, cough, shortness of breath and fatigue [5]. Loss of smelling and taste were also reported by a considerable number of COVID19 cases [6]. Moreover, symptoms of other systems like the Gastrointestinal tract were documented as well [7]. The case fatality ratio (CFR) at the beginning of the pandemic was relatively higher (15%), it is high, most likely, due to the small cohort at the beginning of the pandemic, however, it has then come down to 4%, in specific parts of the world it was even lower with only 0.04% [8]. The disease has higher rates of occurrence among young individuals; however, the fatality of the disease is more in elderly [9,10]. The International Health Regulations (IHR), 2005" requires countries to increase their capacity in communicable diseases detection through development and strengthening of both surveillance systems, indicator-based surveillance (IBS) and event-based surveillance (EBS) [11,12]. The surveillance system in Sudan covers a list of 26 notifiable diseases, the data flows up to the national level through state, locality, and health facility levels. The system functions through well-established both IBS and EBS. The IBS is sentient-based, passive, aggregated, daily and weekly reported system with 1918 reporting sentinel sites (30% of all health facilities). However, during outbreaks, daily zero reporting (zero or no case detected) is required by all sites [13]. In addition, there is a functioning EBS with public health signal of priority epidemic diseases being reported by community volunteers, captured from media and reported by public through the hotline. The surveillance and information Directorate (SID) is part of the General Directorate of Health Emergencies and Epidemics Control (HEEC) at Federal Ministry of Health (FMOH). COVID-19 was included in the list of priority immediately notifiable diseases for Sudan.

COVID-19 surveillance in Sudan considers all reporting sources, as reports come from sentinel sites, laboratories, community, points of entry as well as the direct hotline from the public. After reporting suspected cases, the rapid response teams investigate the cases using standard COVID-19 case investigation form. Moreover, they take sample, ask about active cases, and register contacts for tracing. The form includes social and demographic data, clinical profile, laboratory tests, including RT-PCR test result, medical history, travel history, death status, and lately vaccination status was added. The SID accumulates all the data received nationwide and enter in one national line-list, then analyzed timely to inform decisions and guide actions. The goal of COVID-19 disease surveillance is to keep an eye on the disease trends, morbidity and mortality, and to measure the effectiveness of implemented control interventions. This study describes the pandemic in Sudan and provide retrospective epidemiologic analysis of COVID19 cases to document the country experience with COVID19. We expect our analysis to contribute to the overall international insight and understanding of the diseases and inform better preparedness and planning for the future.

2. Methodology

2.1. Study design

Descriptive cross-sectional (retrospective record review) study.

2.2. Case definition

COVID19 suspected case is "*any person presenting with acute respiratory infection with fever and, as minimum, one of the following features; cough, disturbed breathing, with exclusion of other causes*". In addition, traveling or visiting an infected area within 14 days; history of contact with a confirmed or suspected person within 14 days, or the condition required hospital admission, all are factors that making COVID19 highly probable. A case is considered confirmed if the SARS COV2 virus is identified through the recommended tests [14].

2.3. Data source

The data provided by the SID (it was collected starting from Mar 2020 up to Feb 2021). For epidemic curve more data was provided up to Dec 2021. The data was collected through 98 health facilities across all Sudan states, 41 isolation facilities and 57 laboratories.

The process of data clearance passed a cross three levels: local, state, and federal levels, to assure obtaining correct, validated, and coherent data. We exclude any data that did not meet these criteria.

For ethical purpose, the data from was obtained after getting the approval and permission from HEEC directorate. Anonymous data was used throughout the analysis based on directives of HEEC.

2.4. Data collection

Surveillance officers at locality level used the COVID-19 case report form to collect data, then the data sent to the state level where entry in the line-list and validation take place and finally sent to the federal level. At the federal level states' data compiled and entered to a single national line-list (a Microsoft excel spread sheet). For this study data on selected variables was extracted from the line-list,

these were; age, sex, occupation, contact states, states, date of onset, fever, headache, shortness of breath SOB, cough, test result, and outcome. At the time the data was extracted and provided by SID, the vaccination campaign had not started yet, this is why vaccination status was not included in the analysis.

2.5. Statistical analysis

The extracted data was cleaned and analyzed by "SPSS version 22". The study used frequencies and percentages for data description, while association between dependent and independent variables was determined via univariate logistic regression (LR). Then variables with significant associations (P-values <0.05) selected for the multivariate LR to measure the adjusted odds ratios (ORs) and the 95% confidence intervals (CIs).

3. Results

This section was ordered based on the epidemiologic time, place and person distribution of cases.

3.1. Person distribution

The total of 48,545 suspected COVID19 cases were reported and tested during the period January 28, 2020, to February 7, 2021, of which 27,453 tested positive through RT-PCR (positivity rate, 56.5%).

While 14,780 (53.8%) of confirmed cases were asymptomatic, 12,673 (46.2%) of them reported clinical complaints (Fig. 1. A). The greater proportion of cases reported no history of contact with any infected case (Table 1).

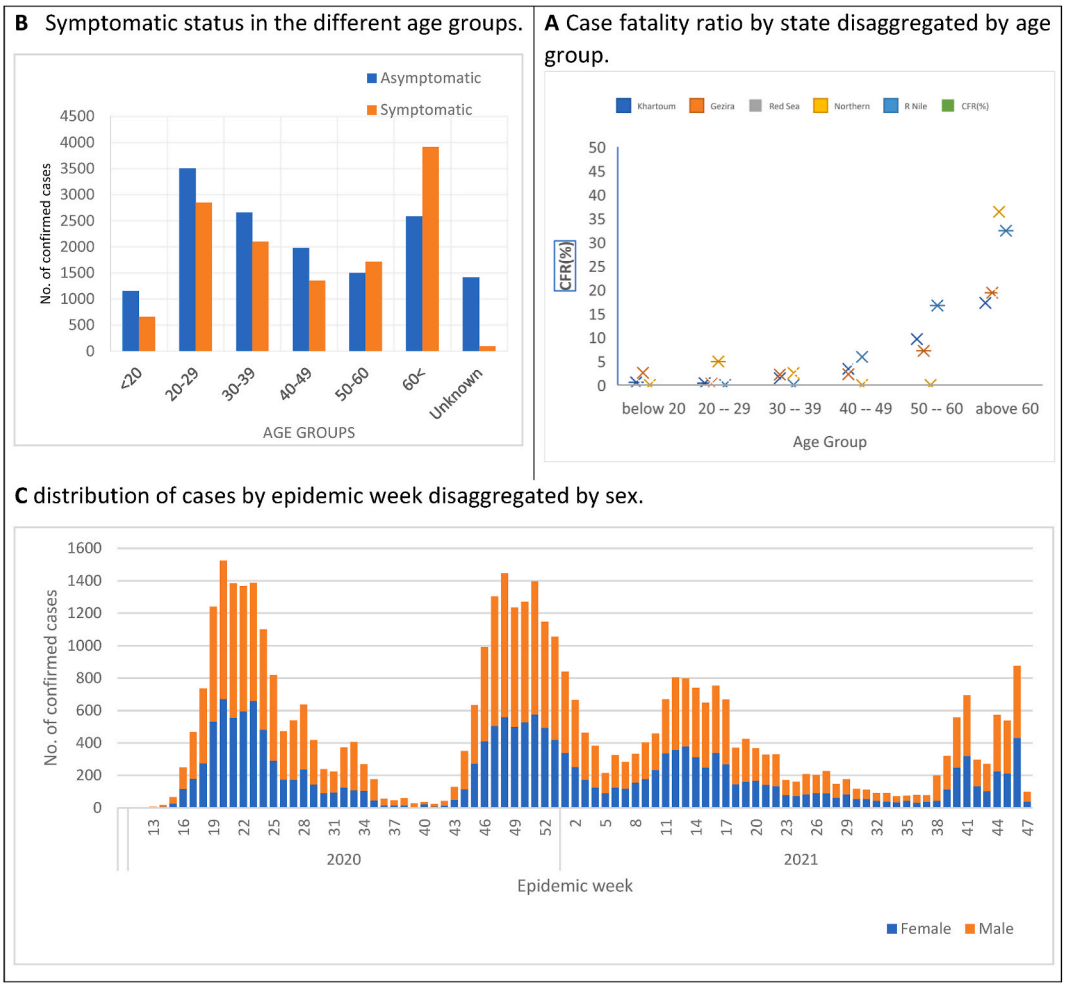


Fig. 1. Shows symptomatic status (A), case fatality ratio by state disaggregated by age group. (B), and distribution of cases by epidemic week disaggregated by sex (C).

The clinical features were; fever (32.7%), cough (26.4%), with shortness of breath (19.1%), sore throat (16.8%), headache (16.7%), and loss of smelling and taste (4.5%). There were 1793 reported death among confirmed, the CFR is 6.5% (Table 1) (see Table 2).

The death was higher among males (70.1%) compared to females with significant difference (*P-value =0.0001*). The CFRs varies between age groups in the reporting states (Fig. 1. B). Higher death rate identified among those over 60 years (Table 1) with a strongly significant association between death and age (*P-value* = 0.0001). The average age was 41.1 years (SD = 19.0), with 16,444 (59.9%) males (male/female ratio = 1.3). Around 56% of cases fell within the age group of 20–50 with 21.6% (5607) of cases above 60 years of age.

3.2. Time distribution

The epidemic curve peaked 4 times known nationally as transmission waves. Wave 1 was in the 20th epidemic week in 2020 where 1524 cases reported, the following wave was in the same year in week 48s with nearly the same number of cases reported, the last two waves were in year 2021 in weak 12 and 47 respectively with lesser cases compared to the early 2 waves (804 cases for wave 3 and 875 cases in wave). A specific alert cut point (proposed threshold) observed after which marked shooting in cases happens in the curve prior to each of the waves. The cut point ranged from 200 to 250 cases (Fig. 2. A).

3.3. Place distribution

Over 85% of the positive cases all over the country were reported from three states: Khartoum state (21,076/76.8%), Gezira State (1962/7.1%), and Red Sea State (741/2.7%).

The observed threshold varied between states with 200–250 cases for Khartoum, (Fig. 2. B), 20–30 cases in Gezira state (Fig. 2. C) and about 10–20 cases in Red Sea (Fig. 2D).

4. Discussion

High number of COVID19 cases were reported within a relatively short period of time, the most affected age group those fall between 21 and 30 years old (30.8%) followed by 31–40 (18.5) this agrees with a finding from a systematic review found the same prevalence among these age groups [15]. Khartoum, Gezira, Red Sea, Northern, and the River Nile were the most affected states. The higher prevalence in these states could be attributed to the high population density, concentration of laboratories particularly in Khartoum, Red Sea and Gezira, and the increased travelers' movement due to presence of land and airports. The greater proportion of

Table (1)
The frequency and percentages of cases characteristics disaggregated by testing result.

	RT-PCR results		
	Negative (%) [a]	Positive (%) *	Total (%) *
Test result (PCR)			
Total suspected cases	–	–	49,493
Total tested	21,1 (43.4)	27,5 (56.6)	48,5 (100)
Age group by years (n = 46,166)[b]			
Below 20	2,5 (12.3)	2,4 (9.20)	4,9 (10.6)
21–30	6,2 (30.8)	6,6 (25.6)	12,9 (27.9)
31–40	3,7 (18.5)	4,5 (17.2)	8,2 (17.8)
41–50	2,7 (13.1)	3,4 (13.2)	6,1 (13.2)
51–60	2,2 (10.7)	3,4 (13.2)	5,6 (12.1)
Above 60	2,9 (14.6)	5,6 (21.6)	8,6 (18.5)
Total	21,1 (100.0)	27,5 (100.0)	48,5 (100.0)
Sex (n=48,400)			
Female	9,4 (44.6)	11,0 (40.1)	20,4 (42.1)
Male	11,6 (55.4)	16,4 (59.9)	28,0 (57.9)
Total	21,0 (100.0)	27,4 (100.0)	48,4 (100.0)
Contact Status (n=27,476)			
No	9,6 (76.8)	12,3 (82.3)	21,9 (79.8)
Yes	2,9 (23.2)	2,7 (17.7)	5,5 (20.2)
Total	12,5 (100.0)	15,0 (100.0)	27,5 (100.0)
Death (n=48,545)			
No	20,8 (98.7)	25, (93.3)	46,4 (95.7)
Yes	265 (1.3)	1,7 (6.5)	2,0 (4.3)
Total	21,0 (100.0)	27,4 (100.0)	48,5 (100.0)
Death by age group (n = 2089)			
<60	124 (41.8%)	393 (21.9%)	517 (24.7%)
>60	172 (58.1%)	1400 (78%)	1572(75.2%)
	296 (100%)	1793 (100%)	2089 (100%)

[a] % Out of total column, except for RT-PCR result.
[b] Difference in total number is due to missing data.

Table 2
The outcome of the multivariate logistic regression model **(n=48,545)**.

Symptoms		Suspected (%)[a]	Confirmed (%)[a]	Total (%)[a]	OR (95% CI)	P-value
Fever	No (R)	13,5 (63.8)	18,5 (67.3)	32,0 (65.8)	1	
	Yes	7,6 (36.2)	9,0 (32.7)	16,6 (34.2)	0.86 (0.83–0.89)	0.0001[a]
Cough	No (R)	15,0 (71.0)	20,2 (73.6)	35,2 (72.5)	1	
	Yes	6,1 (29.0)	7,2 (26.4)	13,4 (27.5)	0.88 (0.84–0.91)	0.0001[a]
Shortness of Breath	No (R)	16,8 (79.7)	22,2 (80.9)	39,0 (80.4)	1	
	Yes	4,3 (20.3)	5,2 (19.1)	9,5 (19.6)	0.93 (0.88–0.97)	0.001[a]
Sore throat	No (R)	16,6 (78.7)	22,8 (83.2)	39,4 (81.2)	1	
	Yes	4,5 (21.3)	4,6 (16.8)	9,1 (18.8)	0.75 (0.72–0.78)	0.0001[a]
Headache	No (R)	16,6 (78.7)	22,9 (83.3)	39,5 (81.3)	1	
	Yes	4,5 (21.3)	4,6 (16.7)	9,1 (18.7)	0.74 (0.71–0.76)	0.0001[a]
Loss of Smell and Taste	No (R)	20,2 (95.9)	26,2 (95.5)	46,5 (95.7)	1	
	Yes	0,9 (4.10)	1,2 (4.50)	2,1 (4.30)	1.11 (1.02–1.21)	0.02[a]
Symptomatic	Yes (R)	9,8 (46.6)	14,8 (53.8)	24,6 (50.7)	1	
	No	11,3 (53.4)	12,7 (46.2)	23,9 (49.3)	1.34 (1.29–1.39)	0.0001[a]

[a] % Out of total column.

cases reported no history of contact with any infected case. This could be attributable to the incorrect data, respondents being unaware of their contacts' health condition, or contacting and asymptomatic infectious carrier [16].

The study reported high proportion of asymptomatic infection, the finding in this study was consistent with a meta-analysis finding where the asymptomatic infection reached up to 40% [17] and event up to 75% [17]. This finding also can be explained by the increased rate of testing for the disease as 58.8% of COVID19 reporting sites were laboratories. Lab testing was required for each traveler leaving Sudan, what made labs functioning as screening sites for travelers leading to increased proportion of tested population what in turn increased detection of asymptomatic cases. The presenting features among symptomatic cases were; fever (32.7%), cough (26.4%), and shortness of breath (19.1%), another study reported the same proportions [8]. However, some evidence showed that SOB is the most frequent symptom, followed by cough and fever [5]. Loss of the sense of smell and taste in this study was reported by 4.5% of patients; this result was low comparing to study of J. Song that reported (11.4%) for loss of smell and (20.6%) for loss of taste [18]. The multivariate analysis revealed that, being asymptomatic is more likely associated with being positive for the disease (Odds *Ratio < 1.34, 95% CI 1.29-1.39*). Many people are tested for as a travel approval prerequisite, in addition, samples were collected from all contacts to be traced even if they were no having symptoms. This could be a reasonable cause for higher proportion of asymptomatic infection. However, further research is needed to explain this finding. This sheds the light on a fact that symptoms are not indicative of having the infection and other approach to search for cases, like screening, are recommended.

The CFRs varies between age groups in the reporting states, but more frequent in males. There was a strong association between age and death. In early February 2021, the deaths reached about 2 million globally [19], furthermore, the CFR fluctuated within the range of 0.1–14%, however the raito of 6.5% is considered high [20,21]. The death was higher among males (70.1%) compared to females, with higher death rate identified among those over 60 years (50.3% of all deaths). it has been reported that COVID19 fatality and risk of death are higher in men compared to women, especially ages above 50 years [21], and in our study, the risk was higher by about 10%. Generally, the increased prevalence of chronic diseases among elderly is a possible explanation for the higher mortality in this group [22], in addition, male gender is associated with higher smoking rate [23]. Unavailability of data on comorbidities and smoking status limited the analysis utility to explain deaths in elder and male population.

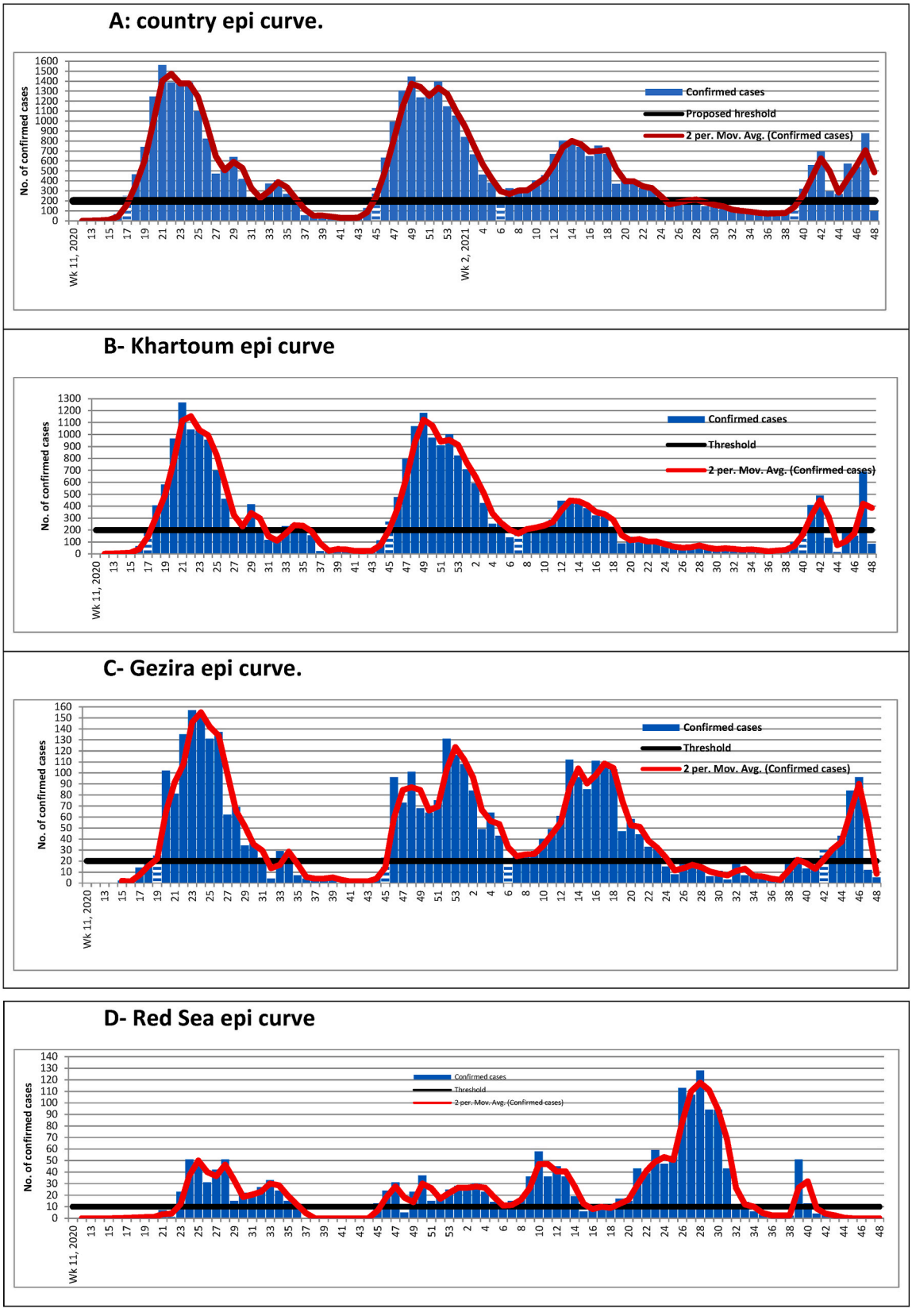
Since its appearance in China many countries were struggling to respond to COVID-19, it reached Sudan in early March 2020 as first case was reported. Cases were slowly increased, then abruptly surged reach over 1000 cases in the 20th epidemic week, 2020, with the maximum weekly reported number of 1560 cases. Simultaneously, COVID19 expanded in the world and mostly affected United States and western European countries [24]. Later in Sudan, the weekly reported cases persisted above 1000 a week for 6 weeks from Jul to Aug 2020. Shortly after, the numbers started to decline to reach 23 in week 42 (in Oct 2020).

The second wave was at the end of year 2020 in December, the weekly number reached 1445 reported cases, this was the longest wave with 10 weeks duration. Marked decline in cases then followed and seen in Feb 2021. Same trend of the pandemic were reported in 73% of the African countries regarding the second wave [25]. The third and the fourth waves in Sudan were in Apr and Nov 2021 respectively. A specific proposed alert threshold of 200–250 cases per week was observed before any peak.

The study tried to understand the epidemic behavior and establish a threshold before any wave, this will direct the initiation and activation of the control measures. Another study attempted to formulate a model using some predicting factors like susceptibility, exposure to infection, being infected, and admission to hospital or quarantine, to predict the volume of the epidemic [26].

5. Conclusions

Efforts of combating COVID- 19 should be directed to the more affected and vulnerable groups regardless of symptoms as a continuous strategy to decrease infection and CFR. The high CFR in the country requires further analysis, as well as the high proportion of asymptomatic infection. This will be ensured by improving the quality and completeness of surveillance data. A proposed threshold of 200–250 cases per week should be an alert to augment the measures of controlling the pandemic over the country, including providing enough intensive care supplies to decrease mortality.



(caption on next page)

Fig. 2. Demonstrates the country epidemic curve (2. A), the epidemic curves of the most affected states, Khartoum (2. B), Gezira (2. C), Red Sea (2. D). The cut point after which the curve shoot is displayed in each curve.
Fig. 2. A: country epi curve. Fig. 2.B- Khartoum epi curve Fig. 2.C- Gezira epi curve. Fig. 2.D- Red Sea epi curve. (For interpretation of the references to colour in this figure legend, the reader is referred to the Web version of this article.)

6. Limitations

Incomplete surveillance data (e.g., comorbidities, smoking history, virus genotype) limits the study ability to provide a more comprehensive analysis.

Travelers screening and samples from contacts increased the proportion of the asymptomatic positive cases what affected the results of association and correlation analysis. There is no clear classification of screened travelers, contacts and tested apparently ill cases, to have separate analysis for ill symptomatic cases.

Financial funds

No funds.

Data availability statement

Obtainable from data archive of federal ministry of health, Republic of Sudan and accessible by the first author upon request.

CRediT authorship contribution statement

Ahmad Izzoddeen: Writing – review & editing, Methodology. **Sabir Abosror:** Formal analysis. **Mustafa Magbol:** Writing – review & editing, Software, Resources, Conceptualization. **Alaa Khalil:** Validation. **Mazza Abasher:** Data curation. **Omer Albadri:** Writing – original draft. **Hafsa Abualgasim Osman:** Writing – original draft. **Esmail Esmail Mohamed:** Supervision. **Abdalla Abdalla Mohamed:** Writing – original draft. **Suleiman Gamal Elgurashi:** Writing – original draft. **Muntasir M. Osman:** Data curation. **Tehani Amin:** Data curation. **Elfadil Mohamed:** Formal analysis. **Babiker Magboul:** Writing – review & editing. **Abdalla Siedahmed:** Writing – review & editing. **Elfatih M. Malik:** Formal analysis.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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