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TREND ANALYSIS AND PREDICTING COVID-19 PANDEMIC OF THE FIRST 2022, IN ETHIOPIA

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ABSTRACT

COVID-19, Caused by the novel coronavirus, was first known officially in Wuhan City, China, and spreads worldwide, including Ethiopia. Globally, as of March 13, 2022, more than 455 million confirmed cases and over 6 million deaths were reported. In Ethiopia, the pandemic cases and deaths gradually increase from time to time and need focus. The study aimed to explore the trend of total cases and deaths of COVID-19 using ARIMA models and predicting the occurrence of COVID-19 cases and deaths in 1st 2022 in Ethiopia. The data were collected from the official website of the Data on COVID-19 by "Our World in Data ."The data on 1st 2022 in Ethiopia is extracted for modeling ARIMA. Model identification, parameter estimation, and model diagnosis were performed. Tests are at alpha 0.05. The total cases of COVID-19, about 469170, and total deaths of 7485, respectively, were observed up to March 12, 2022. ARIMA (0,2,1) for total death and ARIMA (0,2,4) for the total case were estimated by Expert Modeler using SPSS 20 software. The trend shows an increasing pattern daily in total cases and deaths. The 70-day forecast showed in total cases and deaths of COVID-19 in Ethiopia by 1st 2022. This finding is used as a decision-making tool for health interventions and to decrease the spread of the COVID-19 virus.

1. INTRODUCTION

COVID-19, Coronavirus disease 2019 (COVID-19), is defined as an illness caused by a novel coronavirus called SARS-CoV-2, which was first identified as an outbreak of respiratory illness cases in Wuhan City in China. On January 30, 2020, WHO declared the COVID-19 epidemic a global health crisis, and On March 11, 2020, it was declared a global pandemic, including Ethiopia(World Health Organization, 2020). COVID-19 is still causing unprecedented global crises(Gudina et al., 2021). Worldwide, as of March 13, 2022, more than 455 million confirmed cases and over 6 million deaths were recorded. Since January 2022, the number of new weekly cases has been decreasing. It increased by 8% during the week of 7 through March 13, 2022(WHO, 2022). Ethiopian Federal Ministry of Health confirmed a coronavirus disease (COVID- 19) case in Addis Ababa, Ethiopia, on March 13, 2020. In Ethiopia, on March 12, 2022, 17 new deaths were reported across the country. East African countries reported 805 more recoveries, lifting the national count to 140,840. Ethiopia has reported the highest COVID-19 cases in the East African region.

The most recent figures from the Africa Centers for Disease Control and Prevention indicate that Ethiopia's COVID-19 cases accounted for about 4 % of the African continent's total (XinHua, 2022). To manage the pandemic, assessing the rate of the disease spreads is vital. It helps the government develop public health policies and strategies to deal with the pandemic's consequences (Guo et al., 2020). The statistical models apply to forecast and monitor the global threat of the pandemic. Therefore, it is mandatory to create best practice models to support policymakers (Fanelli & Piazza, 2020). The ARIMA model is applied in the field of medical research. ARIMA depends on past series values as well as earlier forecast error terms. However, in short-run forecasting. These models are comparatively more robust and efficient than more complex structural models (Meyler et al., 2014) (Rahman et al., 2020). Different studies also support this idea. A study in Iran showed that the ARIMA model predicts an increase in daily COVID-19 total confirmed cases and deaths(Tran et al., 2020). Similarly, Italy used the ARIMA model to forecast reported and recovered cases of the COVID-19 outbreak. The projection for confirming cases will be more than 182,757, and the recovered cases could be reported at 81,635 at the end of May.

The final findings suggest that there will be a decrease of about 35% in confirmed cases and an increase of 66% in recovering cases (Lepelletier.D, Grandbastien B, Michael J. Smart, 2020). To our knowledge, no study was conducted on the trend analysis and forecasting of COVID-19 in Ethiopia on the 1st of 2022. Thus, the study's main objective was to investigate trends in the spread of COVID-19 using ARIMA models and to find the best predictive model and apply it to the possible predictive occurrence of COVID-19 cases and deaths. Accordingly, this study will assist policymakers in developing new strategies, assessing the existing measures against the COVID-19 pandemic, and predicting health facility needs. The offerings study is to develop the appropriate ARIMA model to see the trend of total cases and deaths of COVID-19 on the 1st of 2022 in Ethiopia.

Furthermore explores a forecasting approach 70 days ahead. Predicting COVID-19 cases using ARIMA is important in Ethiopia because the pandemic has not stopped still. The policymakers may adjust the plan for combating the pandemic. This result is used to check the efficacy of the forecasting models in various situations and plays a more significant role in the upcoming combat against COVID-19 in Ethiopia.

2. METHODS

2.1. Data Sources

The data in this study were collected from regular updates of the officially confirmed total cases and total deaths of COVID- 19 worldwide by "Data on COVID-19 (coronavirus) by Our World in Data, "Available at https://github.com/owid/covid-19-data/tree/master/public/data/ (OWiD, 2022). I consider the 1st 2022 in Ethiopia the data records from 01/01/2022 to 12/03/2022, and 71 days records are considered. The statistical software SPSS version 20 is used for data analysis and graphics. An alpha level of significance=0.05 is used for the statistical tests in the study.

2.2. Statistical models

2.2.1. *Auto-Regressive Integrated Moving Average (ARIMA) Model*

A predicting model approach does not believe specific trends in the historical data of the sequence to be predicted. It considers an interactive approach to identify a possible model for a general model class. The chosen model then tests historical data to see if the sequence is correctly represented or not.

2.2.2. *Moving Average (MA)*

This model focuses on past errors as a dependent variable. Let (t=1;2;3;) be a white noise process, a series of random variables independently and identically distributed (iid) *E(ut)*=0 and *Var (ut)*=σ^2; then the *qth* order MA model is given as:

$$yt = \mu + ut - \theta 1ut - 1 \; - \; \theta 2ut - 2 \; + \ldots + \; \theta qut - q \qquad (1)$$

c correlation between Y t and Y (t-k) controls the possible effects of linear relationships between intermediate lag values. The then is to determine the initial values for seasonality and non-seasonality orders (P and q) (LADDAWAN, 2012).

2.3. Parameter Estimation

Applying Box and Jenkins methodology, Parameters can be estimated by the maximum probability for the time series, which is asymptotically accurate (LADDAWAN, 2012). This study uses SPSS version 20 software to develop the ARIMA model and graphics. The level of significance for the use of statistical tests was set at 0.05. The models selected in the last stage by the Expert Modeler using SPSS 20 were applied to assess the COVID-19 trend and forecast both total cases and deaths of COVID-19 in Ethiopia by 1st 2022.

3. RESULT AND DISCUSSION

3.1. Result

3.1.1. *Descriptive statistics*

The data for the study of total cases and total deaths by COVID-19 were collected from January 1, 2022, to March 12, 2022, in Ethiopia and analyzed. From the summary statistics **in Table 1,** the total cases of COVID-19 were 469170, and the total number of deaths was 7485, respectively, were observed. As shown in **Figure 1,** the pattern graphs of the total and the total deaths showed a gradually increasing trend daily.

Table 1 Descriptive Statistics of total cases and total death by COVID-19 in the 1st 2022 in Ethiopia.

	N	Minimum	Maximum	Sum	Mean	Std. Deviation
total_cases	71	424340	469170	32740448	461133.07	11355.724
total_deaths	71	6947	7485	518806	7307.13	169.024

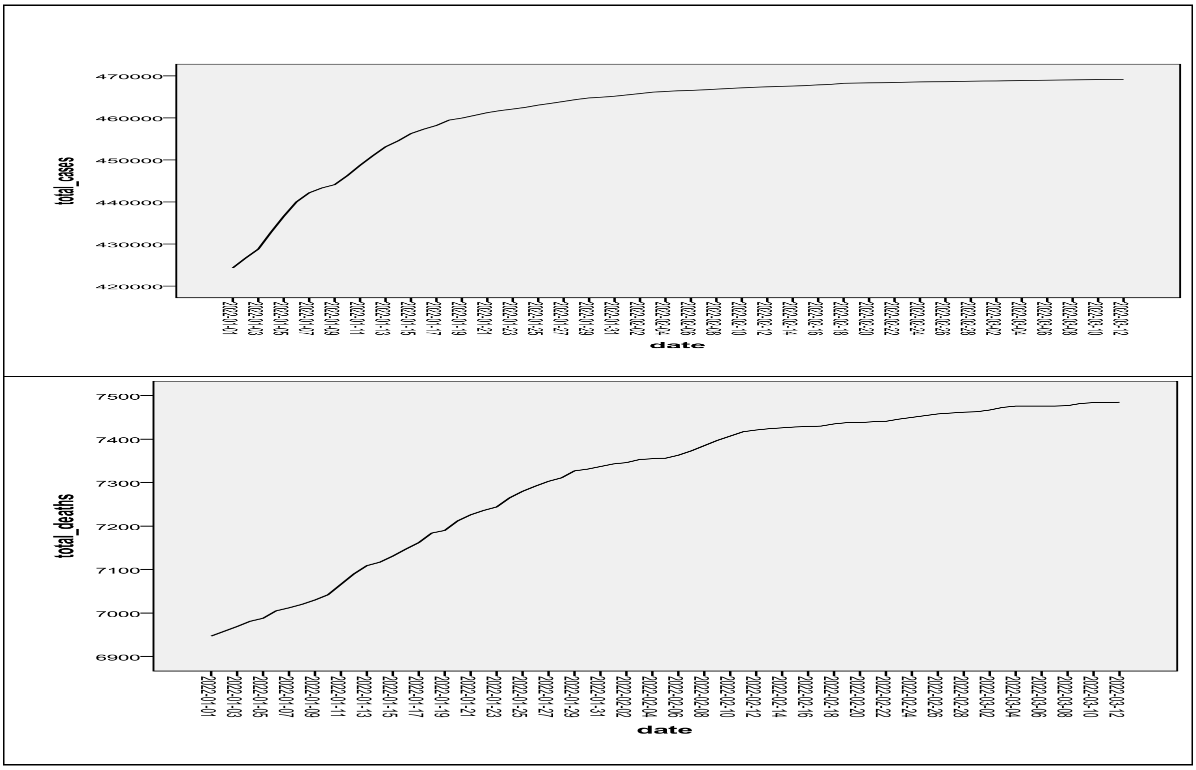


Figure 1 COVID-19 outbreak trend over study time.

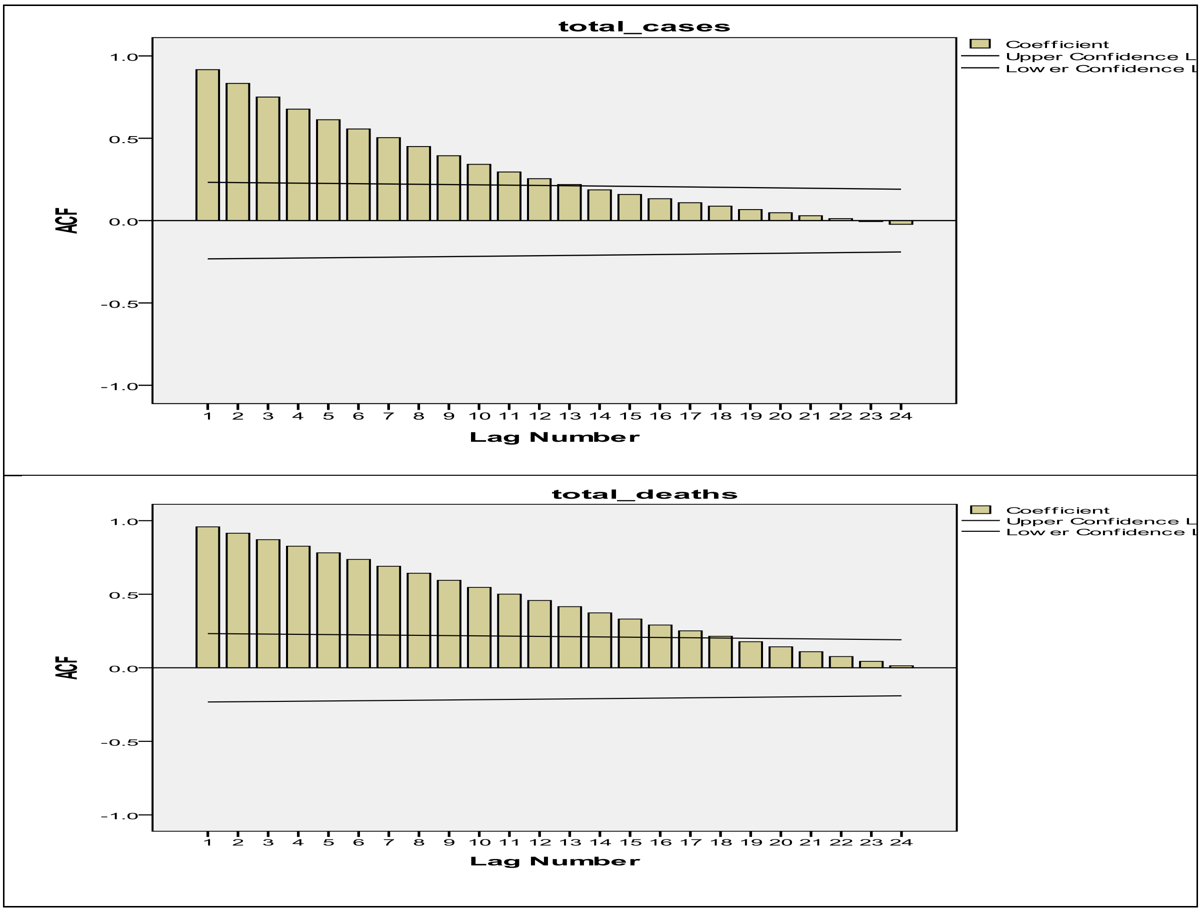


Figure 2 Autocorrelation plot of COVID-19 total cases and total deaths

The autocorrelation function (ACF) is essential to studying the existence of non-stationary. Indicating that the ACF plot is positive and shows a prolonged linear decay; the data are non-stationary, as shown in **Figure 2** above. The problem of non-stationary can be determined by suitable data differencing if it is caused by mean or model transformation caused by variance. It is suggested that to apply the ARIMA modeling technique effectively; the series must be stationary and free from any sort of trend. Thus, the ACF test was used to validate the stationarity observed from the series transformation to confirm the status of total cases and total deaths of COVID-19 in 1st 2022. On the other hand, the time series was not founded to be stationary, which is the natural form of the data, and then we transformed it into stationary by making the first difference. **Figure 3 and Figure 4** below transformed data ACF and PACF showed the constant mean and variance, indicating that the data is changed to stationery.

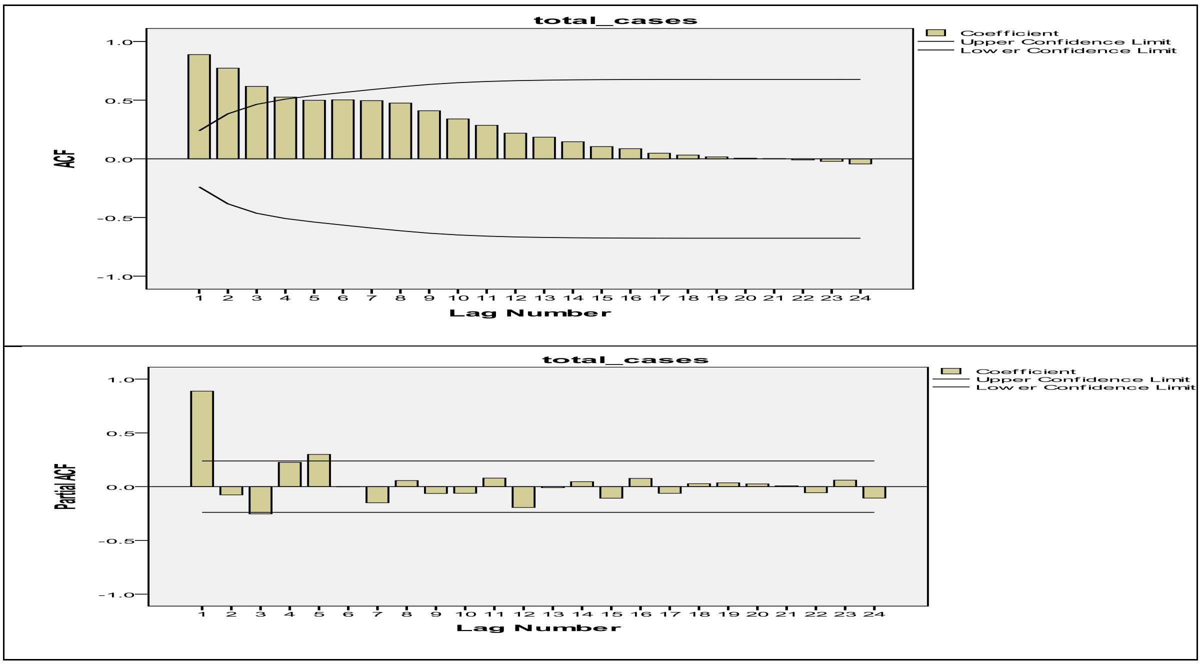
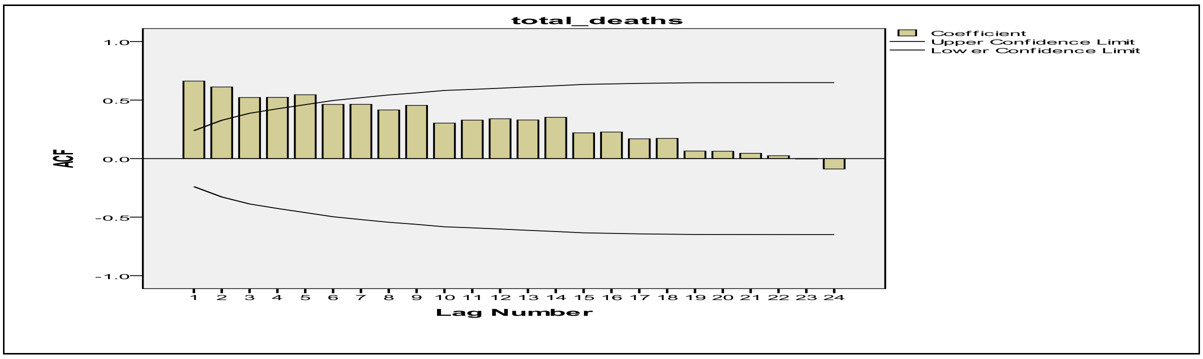


Figure 3 Autocorrelation and Partial autocorrelation function plot of COVID-19 total cases after differencing



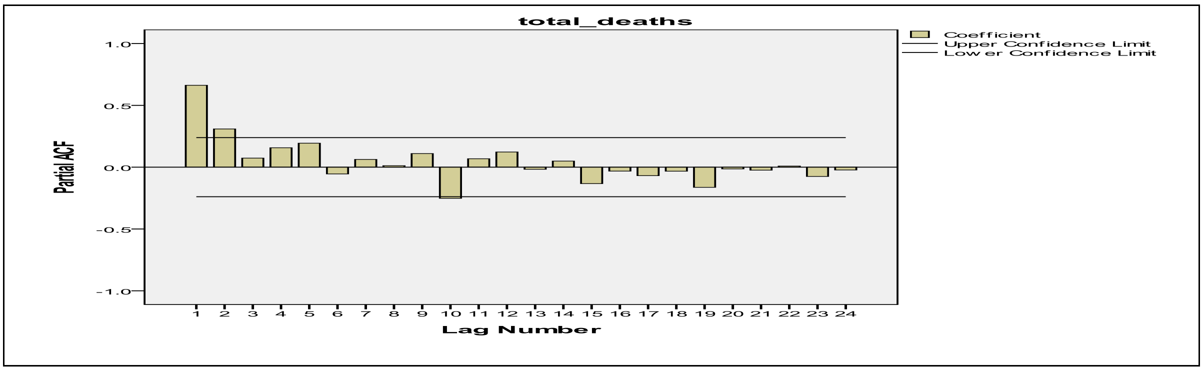


Figure 4 Autocorrelation and Partial autocorrelation function plot of COVID-19 total deaths after differencing

3.1.2. *Candidate Model Identification*

The imperative aspect of IBM SPSS forecasting is the Expert Modeler. It automatically identifies and estimates the best-fitting ARIMA or exponential smoothing model for one or more dependent variable series. Expert modeler eliminates much of the trial and error; hence it is applied in this study (IBM, 2012). The order of the model can be determined based on ACF and PACF after a common difference. The probable ARIMA (0,2,1) for the total deaths and ARIMA (0,2,4) models automatic method of expert modeler using SPSS 20 software the best model to match the daily spread of COVID-19 in the 1st 2022 in Ethiopia.

Table 2 model diagnostics techniques

Model	**Stationary R-squared**					**Ljung-Box Q(18)**		
	Stationary R-squared	**RMSE**	**MAE**	**MaxAE**	**Normalized BIC**	**Statistics**	**DF**	**Sig**
total_cases-Model_1 (ARIMA 0,2,4)	.087	376.751	185.380	1871.000	11.925	18.907	17	.334
total_deaths-Model_2 (ARIMA 0,2,1)	.274	4.510	3.386	13.491	3.074	16.568	17	.484

The Ljung–Box test is usually used in autoregressive integrated moving average (ARIMA) modeling. It is applied to the residuals of a fitted ARIMA model; the null hypothesis is that the residuals from the ARIMA model have no autocorrelation. Both estimated model p-value greater than 0.05 indicates the likelihood of zero autocorrelation in the first m lags, which is required.

3.1.3. *Testing the model coefficients*

The estimated models for total cases and total deaths were ARIMA (0, 2, 4) and ARIMA (0,2,1), respectively. The parameters MA, at lag 4, at difference 2 for total cases, and MA, at lag 1, at difference 2 for total death by COVID-19, are with P-value= 0.000, implying that the coefficients are statistically significant. The model was then estimated forecasting parameter for the daily total cases and total series of COVID-19 on the 1st of 2022 in Ethiopia.

Table 3 Autoregressive Moving Average Model Parameters

Models				Estimate	SE	T	Sig.
total_cases-Model_1	total_cases	Difference		2			
		MA	Lag4	.469	.116	4.028	.000
total_deaths-Model_2	total_ deaths	Difference		2			
		MA	Lag1	.678	.091	0.91 7	.000

3.1.4. *Forecasting Using ARIMA Models*

The daily spread data of COVID-19 in the 1st of 2022 in Ethiopia, the total cases were predicted using the ARIMA (0,2,4) model, and total deaths were predicted using the ARIMA (0,2,1). Consequently, the next 70 days were forecasted. The results indicated that the predicted values matched well with the actual values. According to the model prediction, it is better to be aware of the trend of COVID-19 spreading more than is currently observed. Moreover, the trend of total cases and deaths of COVID-19 in the 1st of 2022 in Ethiopia is expected to grow. As a result, rapid control of the virus in healthcare settings and society is mandatory to reduce the total number of cases and deaths by COVID-19 in Ethiopia.

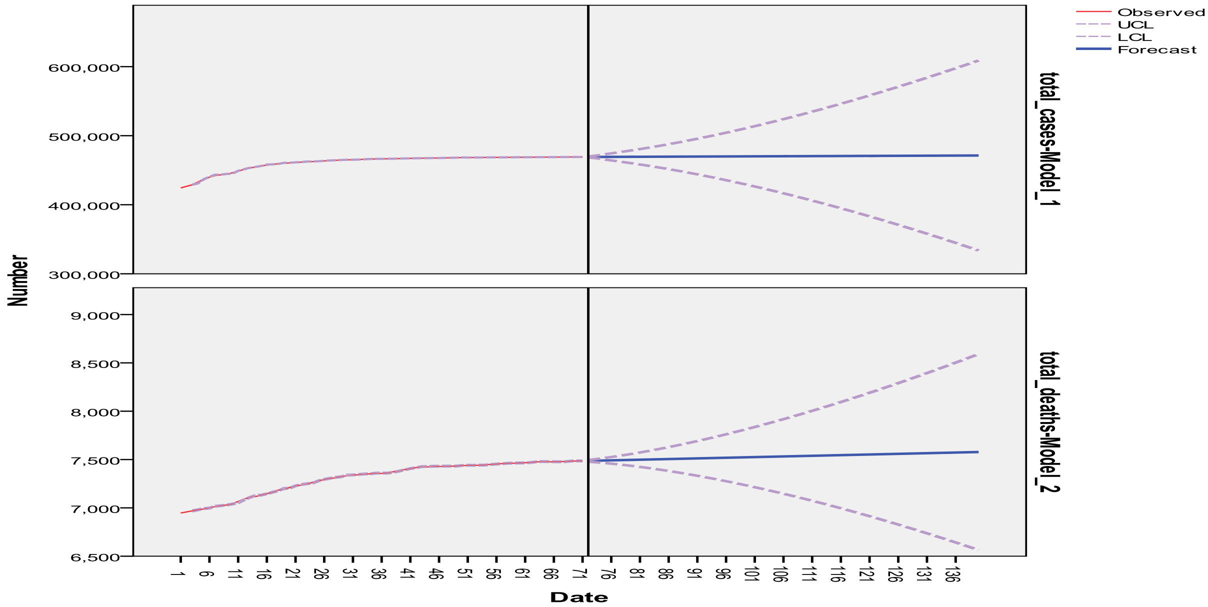


Figure 5 A 70-day forecast of total cases and deaths of COVID-19 according to ARIMA models with a 95% confidence interval in 1st 2022 in Ethiopia.

3.2. DISCUSSION

The study showed the trend and prediction of COVID-19 outbreaks by 1st 2022 in Ethiopia. COVID-19 cases showed an uptrend. On March 12, 2022, total cases and total deaths were 469170 and 7485, respectively, which reflected the significant increase in total cases and deaths during the outbreak of COVID-19 in 1st 2022 in Ethiopia. As of March 13, 2022, this is inline worldwide; over 455 million confirmed cases and over 6 million deaths reported globally indicated an increasing pattern (WHO, 2022). Based on the result of the study, the spread of COVID-19 in Ethiopia was expected to increase. The 70-day forcast observed that the total cases and deaths are increasing. This is in line with a study from Iran that revealed an increase in total cases in April 2020 (Lepelletier.D, Grandbastien B, Michael J. Smart, 2020).

Similarly, the USA expected the highest peak of infection in July 2022 and May 2021 in India. After fitting a suitable model, Ethiopia can apply this model to forecast the trend of COVID-19. This is supported by a study (Ferreira et al., 2021) ARIMA models are an alternative to modeling the behavior of the spread of COVID-19. Expert modeler eliminates much of the trial and error. Hence it is applied in this study (IBM, 2012). The order of the model can be determined based on ACF and PACF after a common difference. The probable ARIMA (0,2,1) for the total deaths and ARIMA (0,2,4) models (Meyler et al., 2014). There are increasing prediction patterns; this is in line with(Asmelash & Asmelash, 2021) and (Tefera AN, 2021). The automatic method of Expert Modeler using SPSS version 20 software developed the model to match the daily spread of COVID-19 on the 1st of 2022 in Ethiopia.

4. CONCLUSION

This research implies ARIMA model is a good model for the trends of COVID-19. In Ethiopia, the spread of COVID-19 in 1st 2022 is expected to increase gradually. Both ARIMA (0,1,5) for the total cases and ARIMA (2, 1, 3) for total deaths were the best models using the automatic Expert modeler. Forecasts have shown that the spread of COVID-19 total cases and deaths in Ethiopia will gradually increase daily for the next 70 days. The study developed an appropriate statistical model which can be used as a decision-supporting method to implement health interventions and alleviate the spread of the Covid-19 virus. Based on this study's findings, the individual's controlling mechanisms focus on decreasing the pandemic's cases and deaths. Researchers may use the ARIMA model for forecasting can be considered good, valid, and satisfactory, even though the forecasted values are classified as reliable forecasts. In addition, as a baseline, other forecasting methods such as exponential smoothing and linear regression model and comparing the results to these best selected ARIMA models. The limitation of the study was that no predictors were evaluated and analyzed, like sociodemographic variables and their constructing social history.

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REFERENCES

Asmelash, Y., & Asmelash, D. (2021). Trend Analysis and Forecasting the Spread of COVID-19 Pandemic in Ethiopia Using Box – Jenkins Modeling Procedure. *International Journal of General Medicine, Dovepress, August 2020*, 1485–1498.

Fanelli, D., & Piazza, F. (2020). Analysis and forecast of COVID-19 spreading in China, Italy and France. *Chaos, Solitons, and Fractals, 134*, 109761. https://doi.org/10.1016/j.chaos.2020.109761

Ferreira, G., Benz-parra, K., & Lo, P. (2021). *Prediction of confirmed cases of and deaths caused by COVID-19 in Chile through time series techniques : A comparative study*. https://doi.org/10.1371/journal.pone.0245414

Gudina, E. K., Gobena, D., Debela, T., Yilma, D., Girma, T., Mekonnen, Z., Woldie, M., Abdena, D., Shume, G., Kenate, B., Lemi, M., & Diriba, D. (2021). COVID-19 in Oromia Region of Ethiopia : a review of the first 6 months ’ surveillance data. *BMJ Open*, 1–9. https://doi.org/10.1136/bmjopen-2020-046764

Guo, Y.-R., Cao, Q.-D., Hong, Z.-S., Tan, Y.-Y., Chen, S.-D., Jin, H.-J., Tan, K.-S., Wang, D.-Y., & Yan, Y. (2020). The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status. *Military Medical Research*, *7*(1), 11. https://doi.org/10.1186/s40779-020-00240-0

IBM. (2012). *IBM SPSS Forecasting*. 48.

LADDAWAN. (2012). *Time Series Analysis* (Issue June).

Lepelletier.D, Grandbastien B, Michael J. Smart, R. B. N. (2020). Since January 2020 Elsevier has created a COVID-19 resource centre with free information in English and Mandarin on the novel coronavirus COVID-. *Ann Oncol*, *January*, 19–21.

Meyler, A., Bank, E. C., & Kenny, G. (2014). *Forecasting irish inflation using ARIMA models*. *January 1999*.

OWiD. (2022). *Data on COVID-19 (coronavirus) by Our World in Data*. https://github.com/owid/covid-19-data/tree/master/public/data/

Rahman, M. L., Islam, M., & Roy, M. (2020). Modeling Inflation in Bangladesh. *Open Journal of Statistics*, *10*(06), 998–1009. https://doi.org/10.4236/ojs.2020.106056

Tefera AN, Z. S. (2021). Trend Analysis and Predictions of Coronavirus Disease 2019 in Ethiopia. *Journal of Research in Health Sciences Journal*, *21*(3). https://doi.org/10.34172/jrhs.2021.59

Tran, T. T., Pham, L. T., & Ngo, Q. X. (2020). Forecasting epidemic spread of SARS-CoV-2 using ARIMA model (Case study: Iran). *Global Journal of Environmental Science and Management*, *6*, 1–10. https://doi.org/10.22034/GJESM.2019.06.SI.01

WHO. (2022). COVID-19 weekly epidemiological update. *World Health Organization*, *58*, 1–23. https://www.who.int/publications/m/item/covid-19-weekly-epidemiological-update

World Health Organization. (2020). Covid-19 Situation Report. *World Health Organization*, *31*(2), 61–66.

XinHua. (2022). *Ethiopia reports 1,332 new COVID-19 cases the country's Ministry of Health said.* http://www.xinhuanet.com/english/africa/2021-03/12/c_139805260.htm