J. Univ. Med. Dent. Coll., Vol.13(1), 299-303;2022
ISSN (Print) 2221-7827, ISSN (Online) 2310-5542
DOI: 10.37723/jumdc.v12i4.655
http://www.jumdc.com/

Opinion Article

Open Access

Trend analysis of COVID-19 cases in Pakistan

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ABSTRACT

BACKGROUND & OBJECTIVE: Statistical models play a significant role in understanding the trend, level and trajectory of infectious diseases and provide the foundation to formulate effective policies and timely intervention, so that the morbidity and mortality due to these diseases can be declined. This study aimed to uncover the trend and proposing a forecasting model for daily expected outbreaks due to COVID-19 of fourth spike in Pakistan.
METHODOLOGY: This study is primarily based on a secondary data of COVID-19 daily confirmed outbreaks. The two-month (1st June to 31st July 2021) time series data is recorded and available from COVID-19 health advisory platform by Ministry of National Health Services Regulation and Coordination official website. Descriptive and time series analysis (ARIMA, exponential smoothing models) were applied. The analysis was carried out using R programming language.
RESULTS: The highest (5026) and the lowest (663), COVID-19 confirm cases reported on 31 July 2021 and 21 June 2021 respective, whereas the average confirmed cases were 1830 [762-2898] per day. Four different time series models are executed namely ARIMA, Brown, Holt and Winter. Among competitive models, ARIMA (0, 2, 1) is found to be an optimum forecasting model, selected by using auto ARIMA function with least root mean square error. A day ahead forecast is obtained under the selected ARIMA model and yielded that COVID-19 confirmed outbreaks is expected to increase about 3.1% per day.
CONCLUSION: COVID-19 outbreaks are expected to rise in Pakistan and ARIMA (0, 2, 1) is an optimum forecasting model for daily COVID-19 outbreaks.
KEYWORDS: ARIMA; COVID-19, Forecast, Pakistan, Time series analysis.

INTRODUCTION

Corona virus disease (COVID-19) pandemic started from Wuhan City of China at the end of December 2019 and became a major health concern across the world. It is a highly infectious disease and within a month more than ten thousand people were infected and hundreds died[1]. World Health Organization (WHO) declared COVID-19 a public health emergency on 30th of January 2020[2]. According to WHO, as of 9 August 2021 the confirmed cases reported worldwide were 202,608306, including 4,293,591 deaths[3]. In Pakistan, the reported cases and deaths till 11 August 2021 were 1,080,360 and 24,085 respectively[4]. Due to fast transmission, COVID-19 has multidimensional impact on health, economy and society etc. worldwide[5-7]. Both developed as well as developing nations are experiencing the COVID-19 pandemic and various measures are taken in designed laboratories for testing, quarantine facilities, special hospitals, awareness campaign and lockdown to control the spread of virus. Due to fast human to human transmission of COVID-19[8], many countries have gone through complete or partial lockdown that has severely affected the global economy[6]. According to United Nation Department of Economic and Social Affairs, the COVID-19 will cut global economy output of about 8.5 trillion dollars for the next two years and pandemic will push more than thirty-four million people into extreme poverty level[9]. Pakistan is facing the most severe delta variant (Indian variant) as the fourth wave which is highly transmissible strain started first from India that has spread rapidly across the globe. Sindh is a major hotspot of delta variant and the positivity rate in Karachi was about 22.32%[10].

Shareef S, Akhtar S, Tufail N, Ahmed F, Imran M. Trend analysis of COVID-19 cases in Pakistan. Journal of University Medical & Dental College. 2022;13(1):299-303.

Predicting behaviour and pattern of disease is an important aspect for policies makers and health personals to formulate adequate polices for disease management and control. As mathematical and statistical models play a significant role in understanding the trend, level and trajectory of infectious diseases and used by epidemiologists to capture the temporal and spatial distribution and patterns of disease spread[11]. Many researchers contributed to highlight the trend of COVID-19 new outbreaks, deaths, recoveries, active cases through modelling. Here we mention few but not limited to the readers, for instance, Aslam M [12] used a kalman filter with autoregressive integrated moving average (ARIMA) model for forecasting the prevalence, recoveries, deaths and active cases related to COVID-19 in Pakistan. Aslam F, [13] also used ARIMA model and forecast the COVID-19 confirmed cases in Pakistan, India and Bangladesh. Chaudhry, Hanif [14] used SPSS time series expert modeller and forecast the COVID-19 cases in Pakistan and concluded that rising trend is expected in COVID-19 cases. Ali M,[15] used R programming packages to predict cumulative confirmed cases, recovered cases and number of deaths through ARIMA models in Pakistan and concluded that ARIMA models forecasting accuracy were better as compared to other competitive time series models. Qiang, Aamir [16] forecasted COVID-19 confirmed outbreaks, deaths and recoveries in Pakistan by using decomposition ensemble model and concluded that the new confirmed outbreaks, recoveries and deaths are expected to increase in Pakistan. Rahimi, Chen [17] conducted a detailed review study and use of forecasting models to predict COVID-19 pattern. By taking into account the accuracy and extensive use of ARIMA model in medical field in predicting infectious disease, we use ARIMA model in the current study to underline the trend of daily COVID-19 confirmed cases of the fourth wave in Pakistan.

METHODOLOGY

In this study we used a secondary data of COVID-19 per day confirmed outbreaks. The two-month (1st June to 31st July 2021) time series data is recorded and available on official website of health advisory platform by Ministry of National Health Services Regulation and Coordination (https://covid.gov.pk). The time series data with no missing value from first June 2021 to 31 July 2021 of Pakistan is used for the time series modelling and analysis. R programming language is used in order to complete descriptive and time series analysis. The reader are referred to Hyndman and Khandakar [18] for detailed discussion and implementation of R time series forecasting package namely 'forecast'. ARIMA and exponential smoothing models (Brown, Holt and Winter) are used. Table-I showed the daily reported confirmed COVID-19 outbreaks across Pakistan. Statistical models play a significant role in understanding the trend, level and trajectory of infectious diseases and provide the foundation to formulate effective policies and timely intervention can be ensured, so that the morbidity and mortality due to these diseases can be declined.

Table-I: COVID-19 confirmed outbreaks (CO) in Pakistan.

Jun-2021				Jul-2021			
Day	CO	Day	CO	Day	CO	Day	CO
1	1843	16	1119	1	1277	16	2783
2	2028	17	1043	2	1400	17	2607
3	1893	18	991	3	1228	18	2452
4	1923	19	1050	4	1347	19	2145
5	1629	20	907	5	830	20	2579
6	1490	21	663	6	1517	21	2158
7	1383	22	930	7	1683	22	1425
8	1118	23	1097	8	1737	23	1841
9	1303	24	1052	9	1828	24	2819
10	1303	25	935	10	1980	25	3752
11	1194	26	901	11	1808	26	3262
12	1239	27	914	12	1590	27	4119
13	1019	28	735	13	1980	28	4497
14	838	29	979	14	2545	29	4537
15	1038	30	1037	15	2327	30	4950
						31	5026

RESULTS

The descriptive analysis of COVID-19 confirmed outbreaks is illustrated in Figure-I and revealed that the average COVID-19 confirmed outbreaks were 1830±1068 per day, whereas the highest confirmed outbreaks 5026 per day were reported on 31 July 2021. The temporal analysis (Figure-II) from first June 2021 to 31 July 2021 yielded that slightly decreasing trend was observed from 1 June 2021 to 30 June 2021. The confirmed COVID-19 cases went high on consistent bases after 1 July 2021. The National Command and Operation Centre (NCOC) called it the fourth wave of COVID-19 in Pakistan and the spread of delta variant, a strain of the virus first identified in neighbouring India.

Table-II: Detail of estimated parameters along with S.E, ARIMA (0, 2, 1).

		80% C.I		95% C.I	
Time	Forecast				
		Low	High	Low	High
Aug-1	5181.557	4746.198	5616.916	4515.733	5847.381

Table-III: Detail of accuracies measures under fitted models.

Measures	RMSE
ARIMA (0,2,1)	331.25
Double exponential smoothing (Brown)	336.37
Double exponential smoothing (Holt)	344.97
Triple exponential smoothing (Winter)	337.77

Fig.1: Box Plot of COVID-19 outbreak

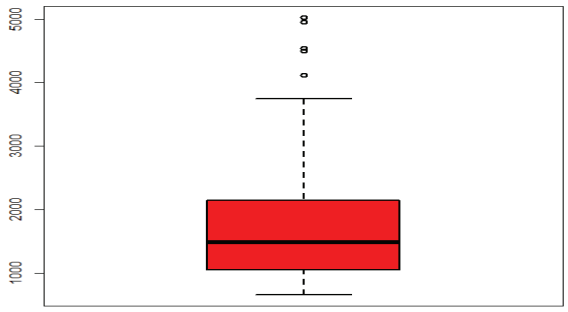


Fig.2:A Plot of COVID-19 outbreak

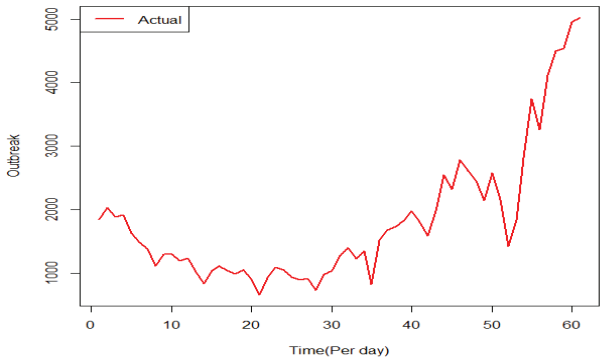
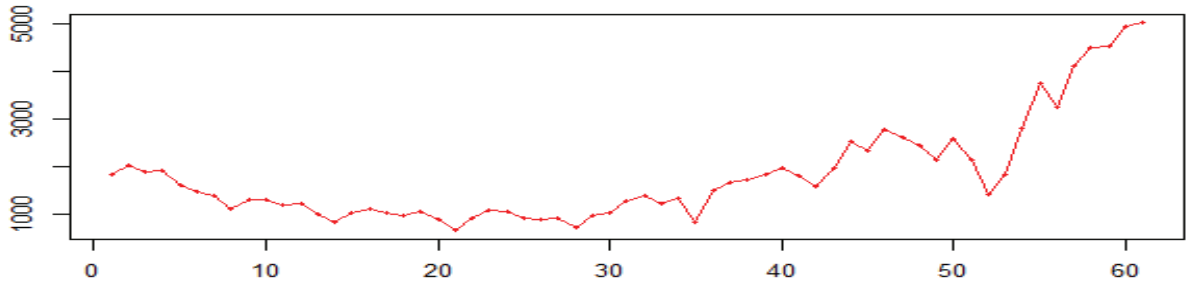
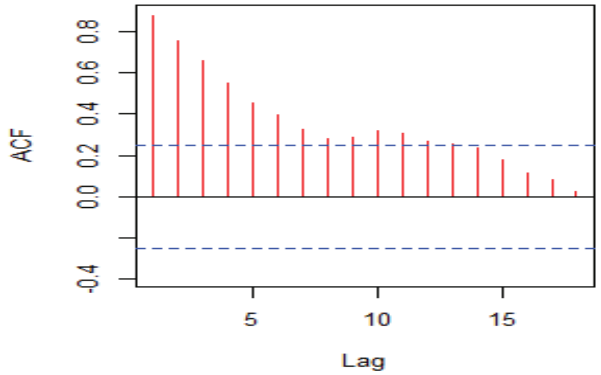


Fig 3: Display of time series





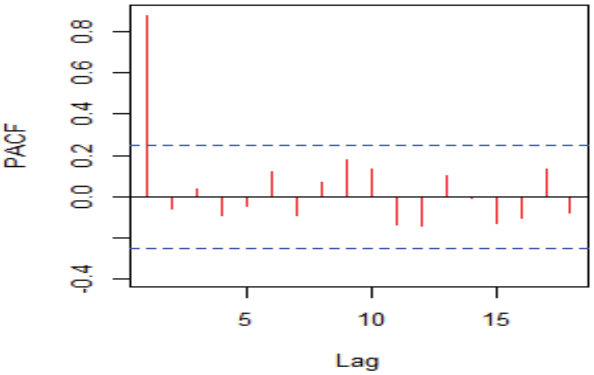


Fig.4:A Plot of Actual & Predicted ARIMA(0,2,1)

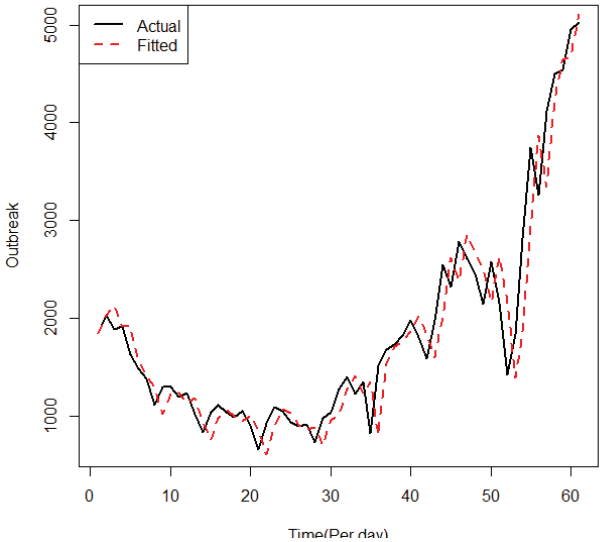


Fig.5:A Plot of Forecasted, ARIMA(0,2,1), C.I 80%, 95%

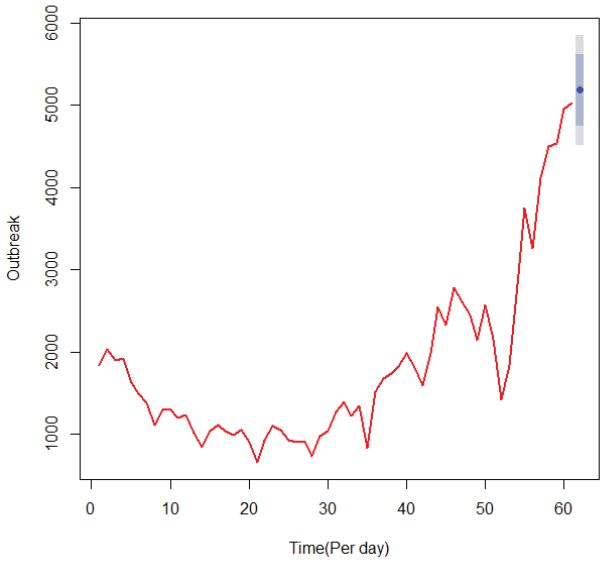


Table-IV: Detail of estimated parameters along with standard error (S.E) of ARIMA (0, 2, 1).

Feature	AR(1)	MA(1)
Parameters	0	-0.9332
S.E	0	0.0484

DISCUSSION

Globally COVID-19 has become a major challenge and yielded adverse impact on health, economy and society[5-7]. Originated from Wuhan city of China and dispersed almost across the world. The novel deadly Corona virus has no cure or vaccine in the beginning, the medical scientists and virologist contributed through scientific studies and underline the epidemiological characteristics[8] and recommended social vaccine that is wearing mask, social distancing and washing hand that can prevent from COVID-19.

As Pakistan is a developing and highly populated country with insufficient economic condition and poor healthcare system. Studies showed that disease outbreaks greatly challenge the health infrastructure of the countries for instance insufficient health policies, lack of health care system, weak governance and general public risking attitude towards preventative measures, increased the likelihood for worst scenario[19-23]. Firouzbakht, [24] conducted a web-based survey to assess the factor affecting the COVID-19 preventative behaviour and concluded that 50% of the respondents have not taken seriously, the COVID-19 preventative measures i.e., wearing mask, washing hand and wearing gloves. On 26 February 2020 two COVID-19 confirmed cases reported in Pakistan, both infected patients had a travel history of border sharing country, Iran. Almost within a month as of 29 March 2020 the confirmed cases gone up to 1547 including 14 causalities, with highest cases in Punjab (558) cases, followed by Sindh (502) and Baluchistan (138) cases[25]. The Government of Pakistan has taken various steps from 26 February to 23 March 2020, in initial phase, for instance closed Pakistan-Iran border, ensure screening and quarantine facilities at Pakistan-Iran border, thermal screening at major airport, public awareness campaign, imposed Section-144, all educational institutions were closed and all international flights were suspended. Countrywide lock-down was imposed on 23rd of March to 25th of April by considering the rising pattern of COVID-19 cases. The readers are referred to Farooq F,[26] for detailed discussion of different phases of lock down and effect on COVID-19 cases. Due to low economic conditions, Pakistan cannot afford countrywide complete lockdown, people will die of hunger rather than COVID-19. Therefore, Pakistan moved to smart lock down and the idea of smart lock down was adopted and acknowledged globally. The idea of smart lock down proved to be beneficial in controlling COVID-19 cases in Pakistan. Despite limited health infrastructure Government of Pakistan effectively implemented the smart lockdown, the current situation is not as worst as in many developing counties. However, the battle is not finished yet. We still need smart, effective and proactive COVID-19 related policies and maximum administration of COVID-19 vaccine doses to the highly vulnerable population. At the same time Government and other NGOs need to launch effective public awareness campaigns to motivate general public for vaccination and to also illuminate the uncertainties and fake propaganda associated to COVID-19 vaccine. As the ARIMA model yielded the rising trend of daily confirmed COVID-19 outbreaks in Pakistan, the NCOC should strictly implement the social vaccine including wearing mask, social distancing and washing hand to stop the spread of delta variant, the fourth spike in Pakistan.

CONCLUSION

In the present study, we used a secondary data of COVID-19 daily confirmed outbreaks. The selected model yielded that COVID-19 confirmed outbreaks are expected to rise in the fourth spike in Pakistan. These statistical results will serve as a guide to understand the trend and pattern of COVID-19 outbreaks in the fourth spike and timely intervention, ultimately achieving the better health outcomes.

ACKNOWLEDGEMENT: None.

CONFLICT OF INTEREST: All authors disclose no conflict of interest.

GRANT SUPPORT & FINANCIAL DISCLOSURE: None.

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Author's Contribution:

Sumera Shareef: Main idea, study design of the manuscript.
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Naima Tufail: Discussion and write up of manuscript.
Fiaz Ahmad: Time series modelling, analysis and result discussion.
Muhammad Imran: Data analysis and R-coding.

Submitted for publication: 17-08-2021
Accepted after revision: 12-01-2022