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Estimating Excess Deaths by Race/Ethnicity in the State of California During the COVID-19 Pandemic

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Abstract

Introduction To examine excess mortality among minorities in California during the COVID-19 pandemic.

Methods Using seasonal autoregressive integrated moving average time series, we estimated counterfactual total deaths using historical data (2014–2019) of all-cause mortality by race/ethnicity. Estimates were compared to pandemic mortality trends (January 2020 to January 2021) to predict excess deaths during the pandemic for each race/ethnic group.

Results Our findings show a significant disparity among minority excess deaths, including 7892 (24.6% increase), 4903 (20.4%), 30,186 (47.7%), and 22,027 (12.6%) excess deaths, including deaths identified as COVID-19-related, for Asian, Black, Hispanic, and White non-Hispanic individuals, respectively. Estimated increases in all-cause deaths excluding COVID-19 deaths were 1331, 1436, 3009, and 5194 for Asian, Black, Hispanic, and White non-Hispanic individuals, respectively. However, the rate of excess deaths excluding COVID-19 recorded deaths per 100 k was disproportionately high for Black (66 per 100 k) compared to White non-Hispanic (36 per 100 k). The rates for Asians and Hispanics were 23 and 19 per 100 k.

Conclusions Our findings emphasize the importance of targeted policies for minority populations to lessen the disproportionate impact of COVID-19 on their communities.

Keywords COVID-19 · Excess mortality · Population health · Healthcare disparity

Introduction

California, the second most racially and ethnically diverse state in the US [1], was the first state to issue mandatory stay-at-home orders to mitigate COVID-19 community spread [2]. Despite this, as of July 31, 2021, the total number of COVID-19 attributed deaths passed 63,935 (163 per 100 k people), with substantial race/ethnic differences [3]. Officially reported COVID-19 deaths of Hispanics accounted for 46% of COVID-19 deaths, and Black and Hispanic individuals experienced the highest per capita deaths [3]. However, these numbers might not reveal the full impact of COVID-19 on mortality and race/ethnic disparities due to undercounting of COVID-19 deaths [4–6]. It is critical for the public health and surveillance system to have an accurate picture of the differential impact of the pandemic for targeted mitigation measures. Estimating excess deaths during the pandemic reveals the severity of COVID-19 for the public health system and for race/ethnic communities.

Although prior research quantified the number of excess deaths occurring during the pandemic compared to pre-pandemic mortality trends [6–16], few studies have examined excess deaths stratified by race/ethnicity [5, 11–16]. We use Seasonal Autoregressive Integrated Moving Average (SARIMA) time series modeling to analyze pre-pandemic vs. pandemic trends in mortality stratified by race/ethnicity. Thus, we estimate the counterfactual number of deaths

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based on historical trends in mortality for each race/ethnic group and predict the numbers of excess deaths. Finally, we compare excess deaths with officially reported deaths from COVID-19 by race/ethnicity.

Methods

Study Setting, Data, and Design

We used monthly mortality data for race/ethnicities in California to undertake time series analyses in order to estimate total all-cause excess deaths due to the pandemic. Data on monthly total all-cause recorded deaths and officially reported COVID-19 mortality data for different races/ethnicities are from the Centers for Disease Control and Prevention (CDC) [17].

Using time series model estimates, we calculated differences between forecasted monthly deaths and total all-cause recorded deaths (excluding COVID-19) from January 2020 to January 2021 to gauge excess deaths for each group.

Statistical Analysis

We employed the Seasonal Autoregressive Integrated Moving Average (SARIMA) model, which has been used to analyze excess COVID-19 deaths in prior research [6]. Historical mortality trends from 2014 to 2019 were used to find the most predictive combination of seasonal autoregressive and seasonal moving average parameters. The SARIMA model produces reliable and accurate forecasting when there are seasonality patterns within the data (see the Appendix). Seasonality, randomness, and time trend are general causes of serial correlation and non-stationarity in time series. Using non-stationary time series produces spurious results, and serial correlation alters the efficiency of estimators. This makes SARIMA a proper choice in comparison with alternative methods.

Data were divided into training (2014–2018) and testing (2019) datasets for out-sample forecasting. Afterward, the model was used to predict excess mortality from January 2020 (when the 1st COVID-19 cases in California were identified) to January 2021. These predicted deaths were compared to all-cause mortality and official COVID-19-related deaths for each race/ethnic group. We calculate the number of deaths per 100,000 population for each race/ethnic group. All analyses used Rstudio (Version 1.4.1717-R 4.0.4) and Stata SE 15.1 (College Station, TX).

Results

The SARIMA model specification was determined based on multiple criteria (see Tables 1, 2, 3, 4, 5 and 6) and Figs. 1, 2, 3 and 4). Our model's prediction shows that total all-cause deaths among race/ethnic groups were higher than expected from 2020 to 2021 (Tables 1, 7, 8 and 9). Recorded all-cause deaths of Hispanics (93,424) exceeded predicted deaths (63,238 (95% confidence interval (CI) 59,198–67,277)) by 30,186 excess deaths—a difference of

Table 1 Model results for predicted deaths, total recorded deaths, and COVID-19-related deaths stratified by race/ethnicity

Deaths	Asian	Black	Hispanic	White non-Hispanic	Total*
Total all-cause recorded deaths	**40,024**	**28,993**	**93,424**	**196,427**	**358,868**
SARIMA predicted deaths based on pre-COVID-19 data	**32,130**	**24,090**	**63,238**	**174,400**	**293,860**
Confidence interval (95%) (upper band–lower band)	(28,884–35,383)	(21,988–26,193)	(59,198–67,277)	(160,946–187,853)	
Excess deaths					
Number	**7,892**	**4,903**	**30,186**	**22,027**	**65,008**
Percentage	24.6	20.4	47.7	12.6	22.1
Per 100 K people	136	226	194	153	172
Official reported COVID-19 deaths, no					
Number	**6,563**	**3,467**	**27,177**	**16,833**	**54,040**
Percentage of excess deaths	83.2	70.7	90	76.4	83.1
Per 100 K people	113	160	174	117	143
Estimated change in all-cause deaths excluding COVID-19 deaths					
Number	**1,331**	**1,436**	**3,009**	**5,194**	**10,970**
Percentage of excess deaths	16.8	29.3	10	23.6	16.9
Per 100 K people	23	66	19	36	29

*We summed the numbers for race/ethnic groups, which account for 96% of the California population

47.7%. 27,177 deaths of the excess deaths were COVID-19 officially reported deaths. Excluding COVID-19 deaths of Hispanics, this implies 3009 all-cause deaths, or 10% of the Hispanic excess deaths, may have occurred as a result of the pandemic (compared to historical trends) and were not recorded as COVID-19 deaths. Blacks experienced 28,993 recorded all-cause deaths, which are 4903 (20.4%) higher than predicted deaths (24,090 (95%CI 21,988–26,193)). This means that 1436 all-cause deaths (29.3% of Black excess deaths) occurred above the recorded COVID-19 deaths for Blacks. Recorded all-cause deaths of Asians (40,024) exceeded predicted deaths (32,130 (95%CI 28,884–35,383)) by 7894 (24.6%) excess deaths, resulting in 1331 all-cause deaths (16.8% of the Asian excess deaths) after we exclude recorded COVID-19 deaths of Asians. Finally, comparing the predicted deaths (174,400 (95%CI 160,946–187,853)) for White non-Hispanics with recorded all-cause deaths (196,427) reveals that there were 22,027 (12.6%) excess deaths (Table 10). Hence, there were 5194 all-cause deaths (23.6% of White non-Hispanic excess deaths) after excluding official COVID-19 deaths of White non-Hispanics. Adjusting for population size, Black individuals had the highest rate of excess deaths per 100 K people (226) followed by Hispanic (194), White non-Hispanic (153), and Asian (136). Increases in all-cause deaths (excluding COVID-19 deaths) per 100 K people were 23, 66, 19, and 36 for Asian, Black, Hispanic, and White non-Hispanic individuals, respectively (Figs. 5, 6, 7 and 8).

Discussion

SARIMA time series modeling suggests that excess deaths during the pandemic are substantial and disproportionately concentrated among minorities. Hispanic excess deaths were nearly 50% higher than the number of deaths that would be predicted based on pre-pandemic mortality trends. Adjusting for population size, Black individuals had the highest rate of excess deaths per 100 k people followed by Hispanics. Reasons for our findings on the substantial race/ethnic disparities in excess deaths are unclear but may be related to differences in socioeconomic status, differential exposure to risk factors (e.g., essential workers), and healthcare-related factors including implicit biases in medical treatment [14, 15, 18, 19, 20]. Education, occupation, income, social status, and political views may alter individuals' decisions about infection and hospitalization risks, mask wearing and other precautions, and so on. For example, low-income individuals may postpone care seeking for mild symptoms due to uninsurance and lack of paid sick leave. In addition, early diagnosis of COVID-19, access to effective COVID-19 treatments, and presence of co-morbidities will affect outcomes from infection.

More research and targeted interventions are needed to increase understanding of the drivers of COVID-19 mortality and identify policy-modifiable solutions to address excess mortality for minorities residing in California. Specifically, considering excess deaths by other causes would produce informative findings regarding COVID-19 disparities in California because mortality from heart disease and other non-COVID-19 health conditions increased during the pandemic in the USA [11]. In fact, our results on all-cause deaths excluding COVID-19 deaths imply that Black individuals followed by White non-Hispanics had the highest per-capita rates. Further research is needed to examine these disparities in non-COVID-19-related causes of mortality.

Recent research on excess deaths suggests that officially reported COVID-19 deaths understate the overall impact of the pandemic on mortality [4–6]. Due to the importance of excess death racial disparities to making proper health equity policy making, it is critical to have a true picture of the pandemic effect on different races/ethnic groups at the state level. Several studies have considered racial and ethnic disparities in COVID-19 mortality [11–16]. However, to our knowledge, there have been only two prior studies on race/ethnic disparities in mortality during the COVID-19 pandemic for the state of California. One study examining the period March to August 2020 reported 2077 excess deaths of Asians, 1882 excess deaths of Blacks, and 8439 excess deaths of Hispanics [14]. The second study on Hispanics reported 10,304 excess deaths in California for this population for the period March 1 to October 3, 2020 [5]. Our study extends this prior work in two key ways. First, we include data updated through January 2021 during which COVID-19 cases substantially increased in California, particularly from November 2020. For example, in contrast to the prior studies' estimates of excess deaths among Hispanics, we find 30,186 excess deaths for this community. Second, we utilize SARIMA, which adjusts for seasonality effects in mortality trends, as well as avoids the non-stationary problem.

There are limitations that should be acknowledged. First, our study findings may not generalize beyond California. Second, we cannot conclude that excess deaths are directly attributable to COVID-19; these deaths may include those that are indirectly related such as disrupted or delayed treatment for critical health issues or undiagnosed health problems. Third, our model uses historical trends in mortality from 2014 to 2019. Above or below average historical periods of mortality may impact the accuracy of forecasts of mortality in 2020 and 2021.

Conclusions

Based on monthly historical trends in all-cause mortality since 2014 and using SARIMA time series modeling, our study showed significant disparities in excess mortality among race/ethnic groups, especially among Hispanic and Black individuals, compared to officially reported COVID-19 deaths. Our findings emphasize the importance of targeted policies for minority populations, such as vaccination strategies or health and social policies, to lessen the disproportionate impact of COVID-19 and future pandemics on their communities.

Appendix

Seasonal autoregressive integrated moving average (SARIMA) regression models is a subset of time series regression model which does not rely on any exogenous variable. Instead, the model employs the past value of the targeted variable to predict future value. Indeed, SARIMA is a general form of the Autoregressive Moving Average (ARMA) model. ARMA model is also the combination of two processes Autoregressive (AR) and Moving Average (MA). AR model describes a time series based on its own past value and a stochastic term. MA model presents a time series by present and past values of a stochastic term. The necessity condition of the ARMA model is stationarity of time series (mean and variance of time series constant over time). Hence, to use the ARMA model, a non-stationary time series is converted to stationary through differencing. The "I" stands for integrated and denotes the order of differencing to make the time-series stationery. To eliminate seasonal components, seasonal differencing is applied. Technically, the "SARIMA (p, d, q)(P, D, Q)S" notion is used to present different components of the SARIMA model in which p indicates the order of the autoregressive model, d and q stand for the amount of differencing and the order of the moving average part, respectively. P is the order for seasonal AR, D is seasonal differencing, Q is the order for seasonal MA, and finally, S is the time span of repeating seasonal patterns [21].

The Box-Jenkins methodology is used to find proper value for p, d, q, P, D, Q, and S. Indeed, there are four essential steps: Model Identification, Model Estimation, Model Diagnostic checking (Checking for autocorrelation), and Forecasting with the model. Practically, the first step is detecting non-stationary in time series by Augmented Dickey-Fuller unit-root test and HEGY Seasonal unit-root test, which determines the "I" and "S." Then, the general form of process and appropriate values of p and q should be determined based on Auto Correlation Function (ACF) and Partial Auto Correlation Function (PACF) patterns. PACF measures the correlation of the values that are k periods apart after removing the correlation from intervening lags (see Figs. 5, 6, 7, and 8,). The next step is using Akaike's information criterion, Bayesian information criterion, and criteria of forecasting accuracy to find the best model. In addition, the SARIMA coefficients should be considered carefully. Indeed, we select our models based on the following process. We give priority to AIC and BIC, which means that we select the model with the lowest AIC and BIC. However, if there are models with significantly lower MSE and MAPE we choose a model with lower MSE and MAPE. In this condition, we check the significance of SARIMA coefficients. For example, for White people, we choose the 5th model since it has the lowest AIC and BIC. However, there are models with significantly lower MSE and MAPE than the selected model. The 1st model's MAPE is 40% lower than the 5th model. Hence, based on our selection process, we choose the model with the second-lowest AIC and BIC. Moreover, we carefully checked the estimation results, and most of the coefficients were insignificant for the 1st model (see Tables 5 and 6). Forecasting the expected mortality using the selected model is the final task.

Table 2 Results of criterion and criteria of forecasting accuracy to select the best model

Asian				
Model	AIC	BIC	MSE	MAPE
SARIMA(1,1,0)(2,1,0)12	587.38	596.64	22,710.69	4.91%
SARIMA(1,1,1)(2,1,0)12	570.77	581.87	19,931.24	4.31%
SARIMA(1,1,0)(1,1,0)12	590.95	598.35	22,724.77	4.85%
SARIMA(1,1,0)(2,1,1)12	588.87	599.97	19,931.24	4.31%
SARIMA(1,1,1)(1,1,1)12	588.87	599.97	22,717.52	4.93%
SARIMA(1,1,1)(2,1,1)12	572.77	585.72	19,942.12	4.31%
SARIMA(1,1,0)(3,1,0)12	588.84	599.94	22,713.46	4.93%
SARIMA(0,1,1)(2,1,0)12*	569.35	578.60	19,366.69	4.29%
SARIMA(0,1,1)(2,1,1)12	571.33	582.43	19,374.74	4.29%

AIC Akaike's information criterion, *BIC* Bayesian information criterion, *MSE* mean square of errors, *MAPE* mean absolute percentage error. *Selected model

Table 3 Results of criterion and criteria of forecasting accuracy to select the best model

Black				
Model	AIC	BIC	MSE	MAPE
SARIMA(1,1,0)(2,1,0)12*	542.62	551.87	8,103.37	4.65%
SARIMA(1,1,0)(1,1,0)12	553.56	560.96	8,163.95	4.67%
SARIMA(1,1,0)(2,1,1)12	544.43	555.54	8,345.04	5.06%
SARIMA(1,1,1)(1,1,1)12	544.43	555.54	8,110.88	4.66%
SARIMA(1,1,0)(3,1,0)12	544.43	565.54	8,116.18	4.76%

AIC Akaike's information criterion, *BIC* Bayesian information criterion, *MSE* mean square of errors, *MAPE* mean absolute percentage error. *Selected model

Table 4 Results of criterion and criteria of forecasting accuracy to select the best model

Hispanic				
Model	AIC	BIC	MSE	MAPE
SARIMA(1,1,0)(2,1,0)12	608.66	617.92	44,700.96	3.58%
SARIMA(1,1,1)(2,1,0)12*	600.44	611.54	49,951.90	4.17%
SARIMA(1,1,0)(1,1,0)12	618.41	625.81	45,315.21	3.62%
SARIMA(1,1,0)(2,1,1)12	610.66	621.76	49,951.90	4.17%
SARIMA(1,1,1)(1,1,1)12	610.66	621.76	44,679.52	3.58%
SARIMA(1,1,1)(2,1,1)12	602.05	615.00	51,095.09	4.24%
SARIMA(1,1,0)(3,1,0)12	610.66	621.76	44,679.92	3.58%
SARIMA(2,1,0)(2,1,2)12	609.14	623.94	49,835.44	3.75%
SARIMA(3,1,0)(3,1,0)12	605.50	620.30	52,796.08	3.85%

AIC Akaike's information criterion, *BIC* Bayesian information criterion, *MSE* mean square of errors, *MAPE* mean absolute percentage error. *Selected model

Table 5 Results of criterion and criteria of forecasting accuracy to select the best model

White non-Hispanic				
Model	AIC	BIC	MSE	MAPE
SARIMA(1,1,0)(2,1,0)12*	726.78	736.03	692,464.45	4.14%
SARIMA(1,1,0)(1,1,0)12	731.23	738.63	688,284.86	4.22%
SARIMA(1,1,0)(2,1,1)12	728.10	739.20	1,107,037.37	6.79%
SARIMA(1,1,1)(1,1,1)12	728.10	739.20	694,884.74	4.14%
SARIMA(1,1,1)(2,1,1)12	717.68	730.63	1,106,587.07	6.79%
SARIMA(1,1,0)(3,1,0)12	728.04	739.14	694,770.31	4.14%

AIC Akaike's information criterion, *BIC* Bayesian information criterion, *MSE* mean square of errors, *MAPE* mean absolute percentage error. *Selected Model

Table 6 Results of SARIMA regression models

SARIMA Model	Coef	P > z	[95% conf. interval]	
Asian				
MA(1)	−1.00	1.0	−2750.84	2748.84
Seasonality AR(1)	−0.77	< 0.01	−1.19	−0.35
Seasonality AR(2)	−0.40	0.09	−0.85	0.06
Black				
AR(1)	−0.51	< 0.01	−0.83	−0.18
Seasonality AR(1)	−0.67	< 0.01	−0.94	−0.40
Seasonality AR(2)	−0.64	< 0.01	−0.92	−0.36
Hispanic				
AR(1)	0.12	0.45	−0.19	0.44
MA(1)	−0.98	1.00	−1001.20	999.20
Seasonality AR(1)	−0.43	0.01	−0.73	−0.13
Seasonality AR(2)	−0.60	< 0.01	−0.85	−0.34
White non-Hispanic				
AR(1)	−0.41	0.00	−0.65	−0.17
Seasonality AR(1)	−0.26	0.04	−0.51	−0.02
Seasonality AR(2)	−0.53	< 0.01	−0.89	−0.17

AR autoregressive, *MA* moving average; 1: first lag of the variable and 2: second lag of the variable

Table 7 Results of out-of-sample (January 2020 to January 2021) predicted numbers of deaths during the pandemic from the SARIMA model—Asian

Asian			[95% prediction interval]	
Month	Recorded	Predicted	Lower bound	Upper bound
2020M01	2711	2730	2534	2926
2020M02	2612	2599	2336	2862
2020M03	2764	2724	2451	2997
2020M04	2870	2430	2181	2679
2020M05	2670	2398	2152	2645
2020M06	2495	2237	2004	2471
2020M07	2630	2239	2006	2473
2020M08	2818	2244	2010	2478
2020M09	2627	2147	1917	2378
2020M10	2563	2409	2162	2656
2020M11	2817	2386	2141	2631
2020M12	4749	2720	2447	2993
2021M01	5698	2869	2543	3194

AR autoregressive, *MA* moving average; 1: first lag of the variable and 2: second lag of the variable

Table 8 Results of out-of-sample (January 2020 to January 2021) predicted numbers of deaths during the pandemic from the SARIMA model—Black

Black			[95% prediction interval]	
Month	Recorded	Predicted	Lower bound	Upper bound
2020M01	2022	2044	1882	2207
2020M02	1846	1813	1663	1963
2020M03	2030	2000	1820	2181
2020M04	2219	1803	1649	1956
2020M05	2044	1818	1662	1974
2020M06	1926	1794	1642	1947
2020M07	2178	1739	1594	1883
2020M08	2266	1645	1502	1789
2020M09	1990	1690	1552	1827
2020M10	1969	1787	1636	1938
2020M11	2018	1834	1676	1993
2020M12	3071	2007	1824	2190
2021M01	3414	2116	1886	2345

AR autoregressive, *MA* moving average, *1* first lag of the variable and *2* s lag of the variable

Table 9 Results of out-of-sample (January 2020 to January 2021) predicted numbers of deaths during the pandemic from the SARIMA model—Hispanic

Hispanic			[95% prediction interval]	
Month	Recorded	Predicted	Lower bound	Upper bound
2020M01	5461	5401	5140	5663
2020M02	4924	4823	4510	5135
2020M03	5161	5179	4847	5512
2020M04	5656	4719	4411	5027
2020M05	5943	4853	4538	5168
2020M06	5973	4614	4311	4916
2020M07	7302	4431	4139	4723
2020M08	7110	4614	4311	4916
2020M09	5903	4533	4235	4831
2020M10	5668	4690	4384	4997
2020M11	6396	4646	4342	4950
2020M12	12,118	5171	4839	5504
2021M01	15,809	5563	5191	5935

AR autoregressive, *MA* moving average; 1: first lag of the variable and 2: second lag of the variable

Table 10 Results of out-of-sample (January 2020 to January 2021) predicted numbers of deaths during the pandemic from the SARIMA model—White non-Hispanic

White non-Hispanic			[95% Prediction Interval]	
Month	Recorded	Predicted	Lower Bound	Upper Bound
2020M01	14,981	14,859	13,876	15,841
2020M02	13,868	13,617	12,630	14,604
2020M03	14,533	14,772	13,702	15,842
2020M04	14,226	13,304	12,297	14,312
2020M05	13,674	13,241	12,229	14,253
2020M06	12,951	12,739	11,696	13,782
2020M07	14,527	12,779	11,738	13,820
2020M08	14,676	12,351	11,284	13,418
2020M09	13,354	12,083	10,999	13,166
2020M10	13,671	13,112	12,091	14,132
2020M11	14,536	13,007	11,981	14,034
2020M12	19,870	13,979	12,955	15,003
2021M01	21,560	14,557	13,468	15,646

AR autoregressive, *MA* moving average; 1: first lag of the variable and 2: second lag of the variable

Figure

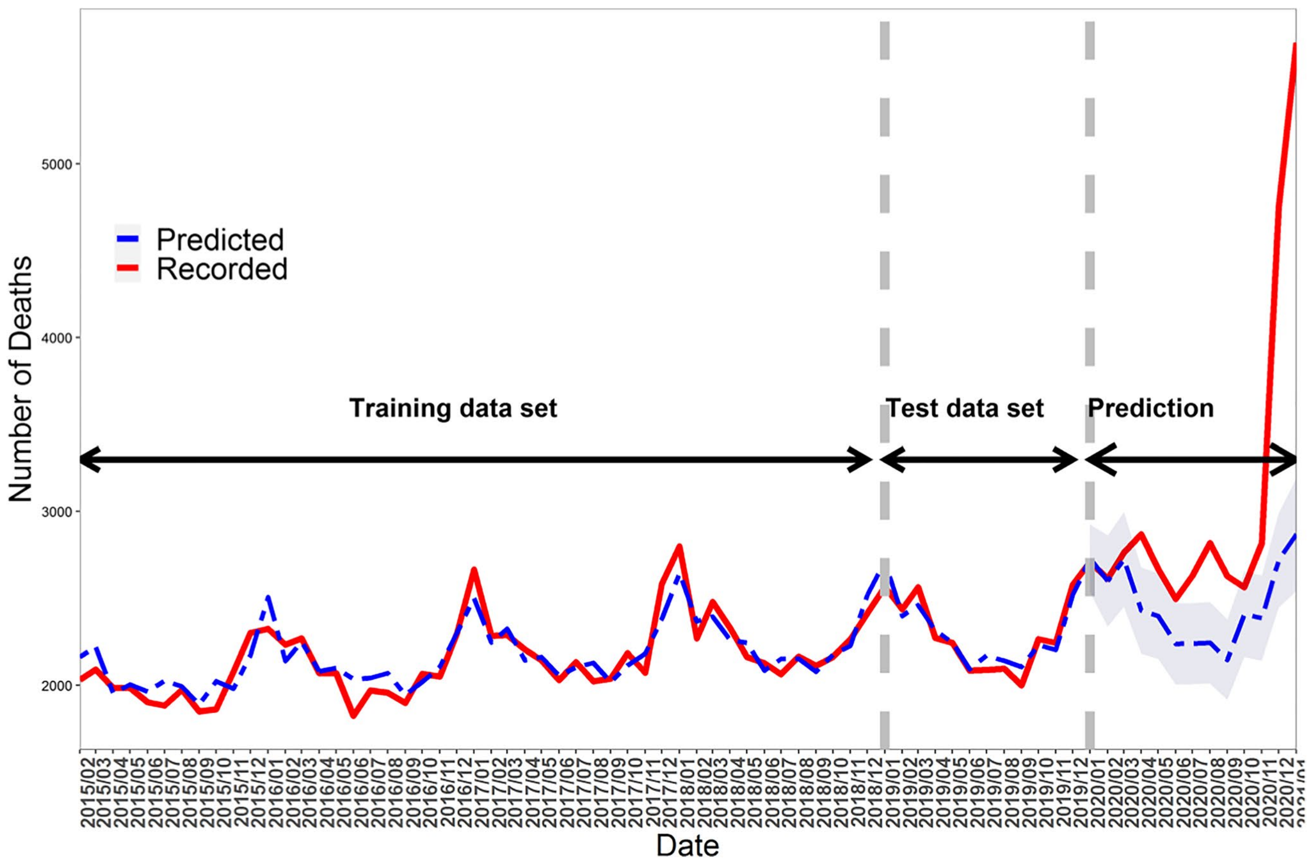

Fig. 1 Asian monthly total all-cause recorded deaths, SARIMA predicted deaths and officially reported COVID-19 deaths in California. Bounds denote 95% confidence intervals for forecasts

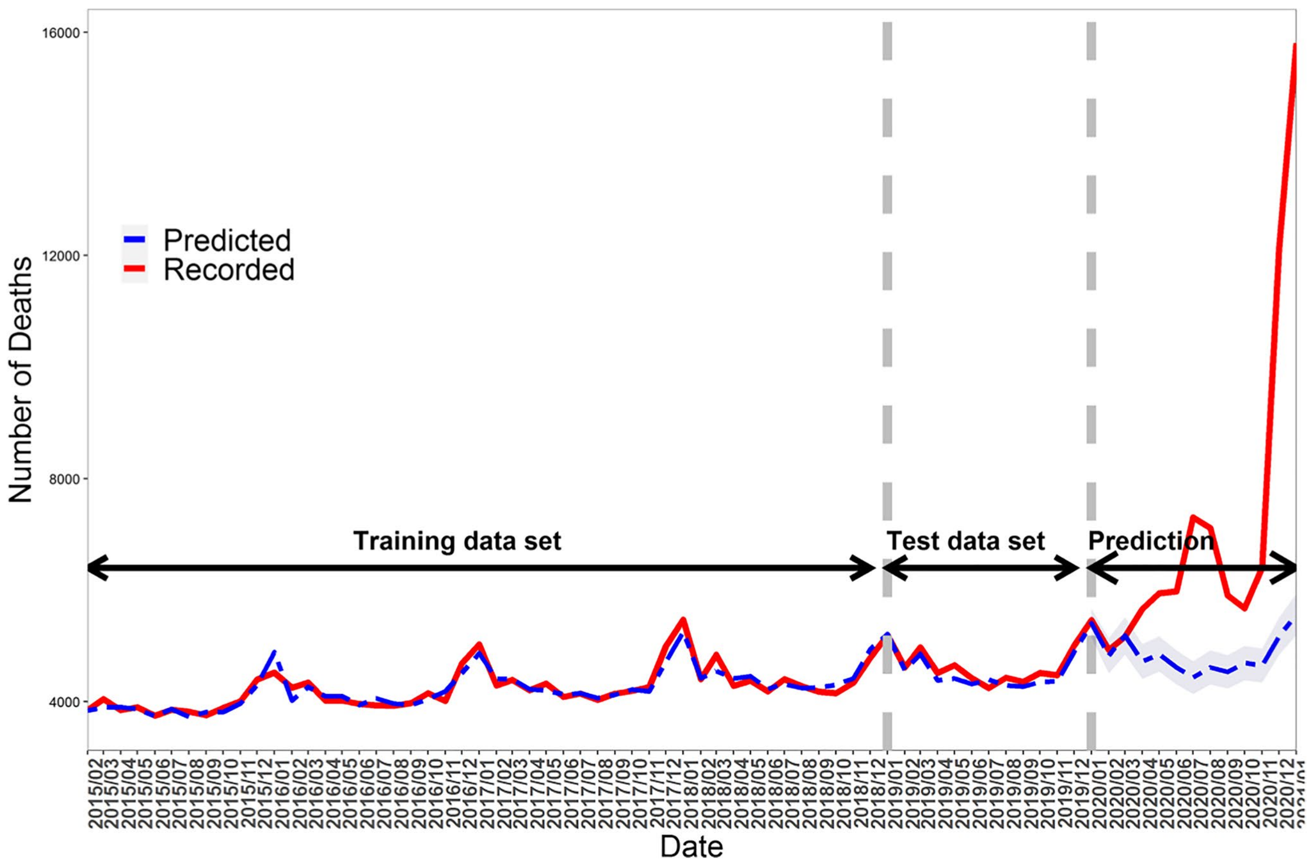

Fig. 2 Hispanic monthly total all-cause recorded deaths, SARIMA predicted deaths and officially reported COVID-19 deaths in California. Bounds denote 95% confidence intervals for forecasts

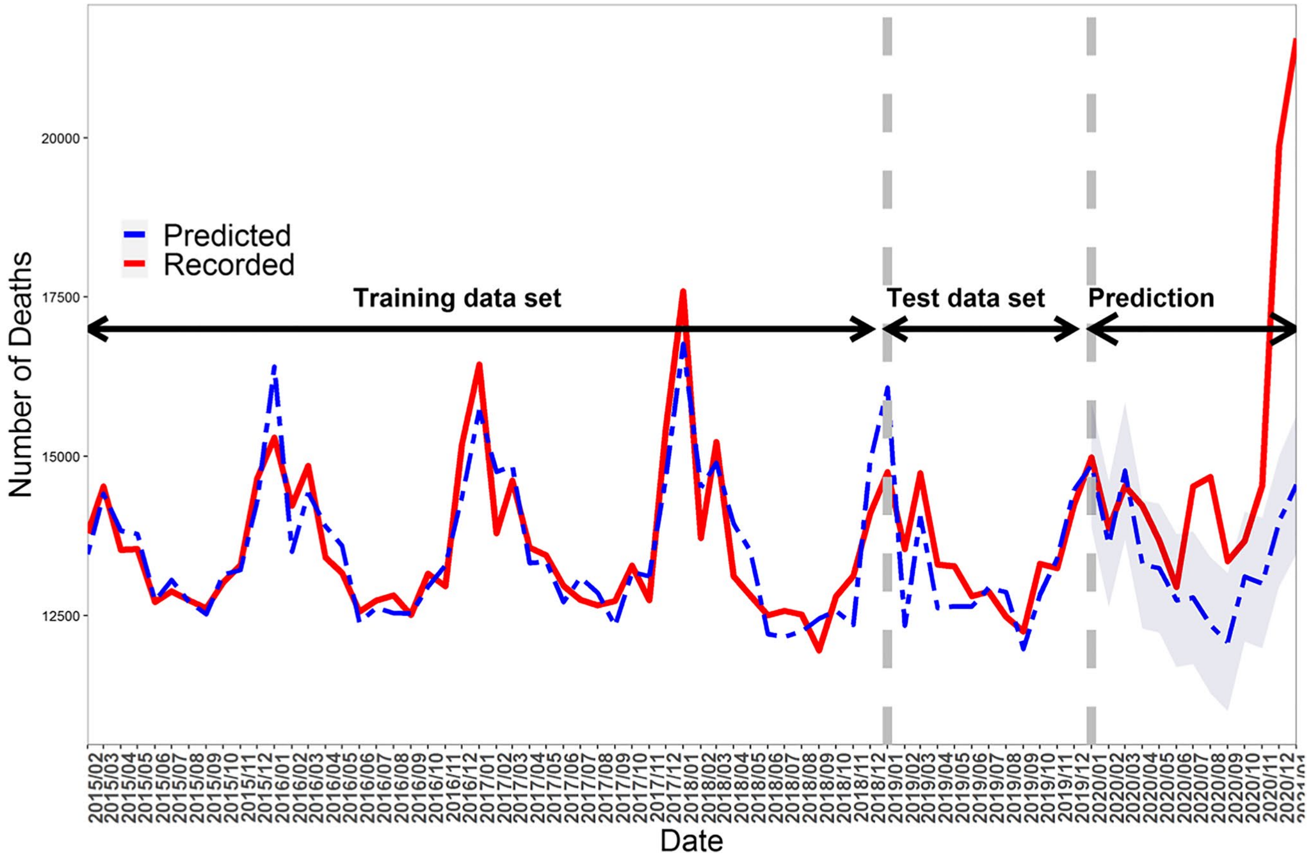

Fig. 3 White non-Hispanic monthly total all-cause recorded deaths, SARIMA predicted deaths and officially reported COVID-19 deaths in California. Bounds denote 95% confidence intervals for forecasts

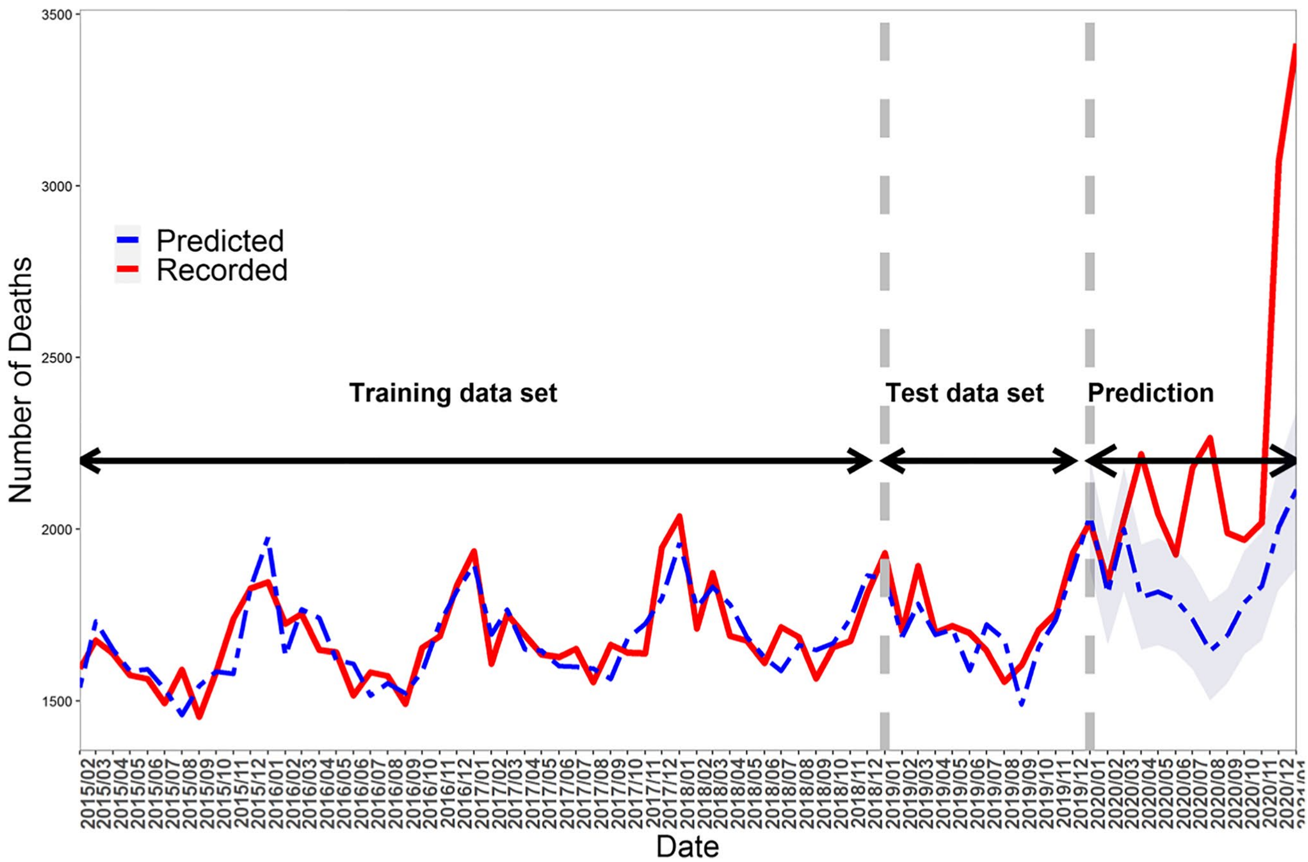

Fig. 4 Black monthly total all-cause recorded deaths, SARIMA predicted deaths and officially reported COVID-19 deaths in California. Bounds denote 95% confidence intervals for forecasts

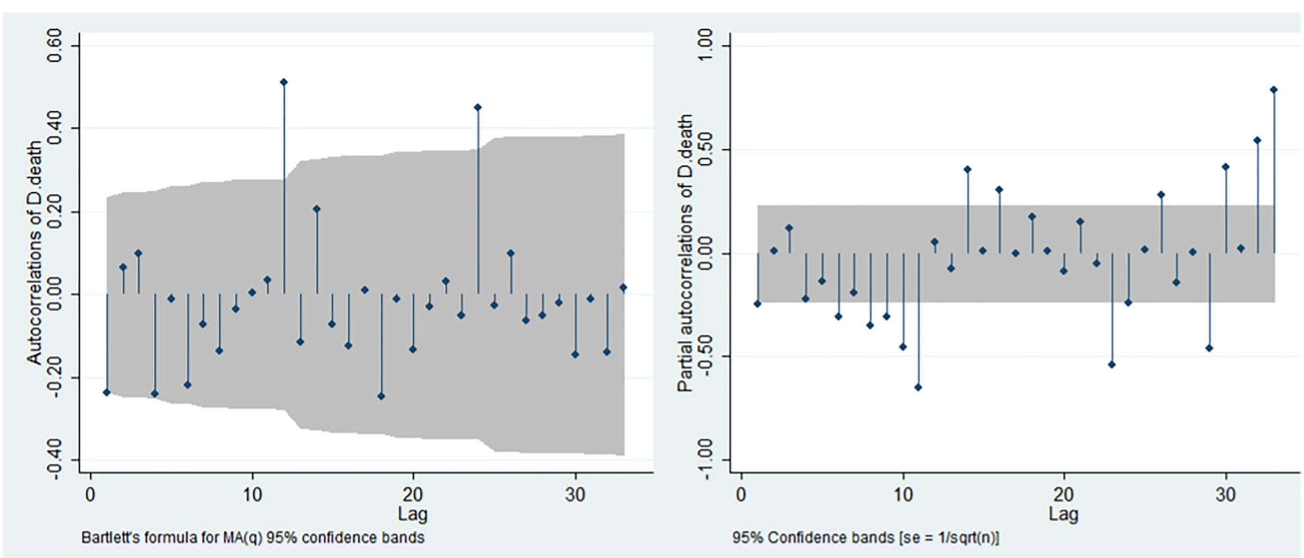

Fig. 5 Autocorrelation function (ACF) (left) and partial autocorrelation (PACF) correlogram (right) for first difference of time series—Asian

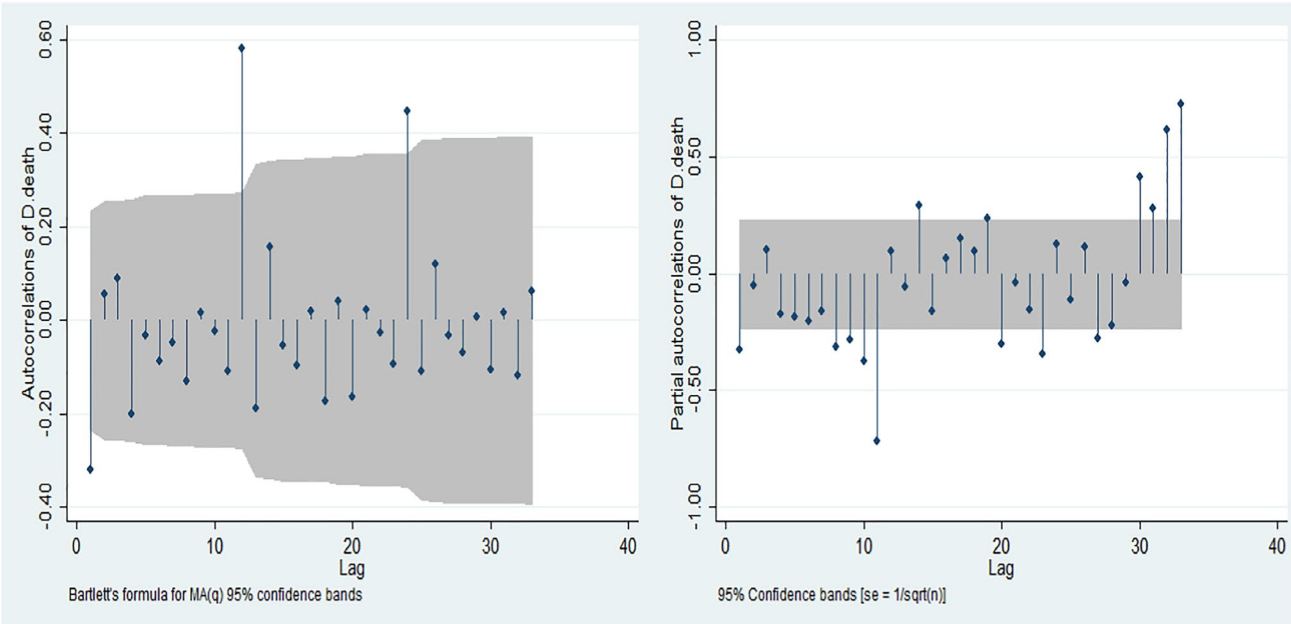

Fig. 6 Autocorrelation function (ACF) (Left) and partial autocorrelation (PACF) correlogram (right) for first difference of time series—Black

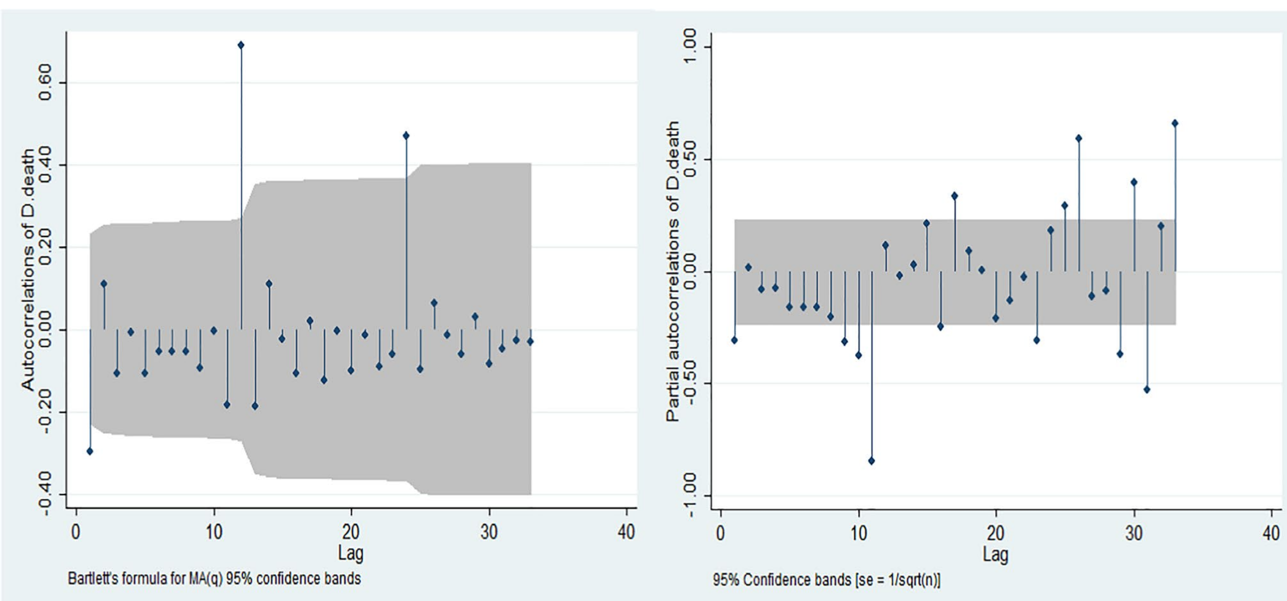

Fig. 7 Autocorrelation function (ACF) (left) and partial autocorrelation (PACF) correlogram (right) for first difference of time series—Hispanic

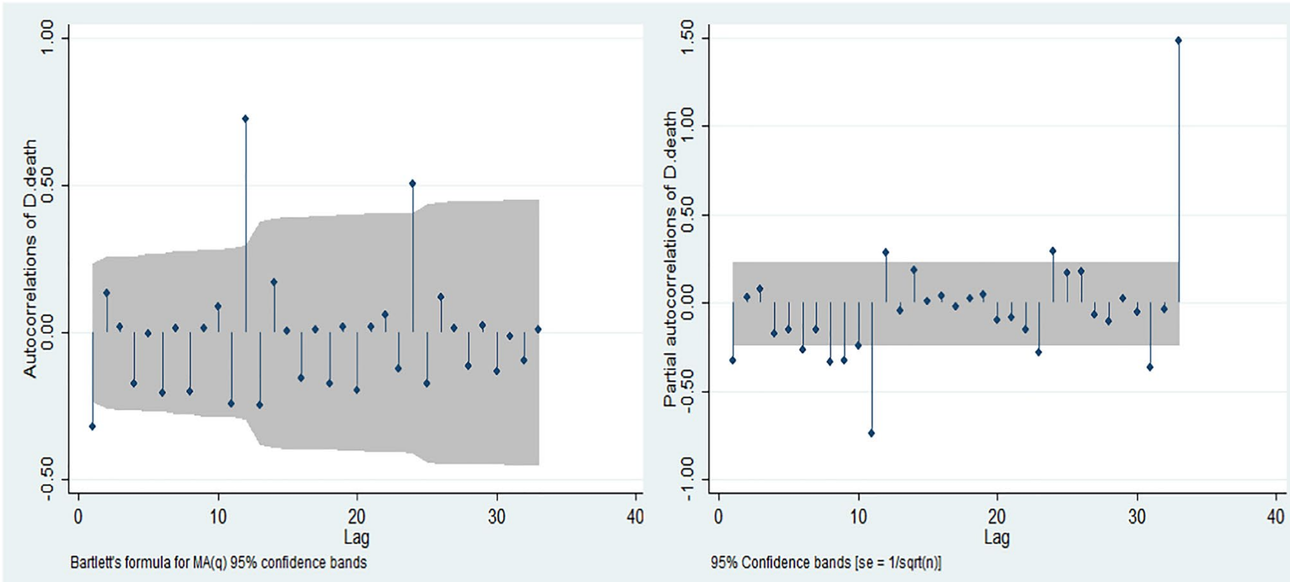

Fig. 8 Autocorrelation function (ACF) (left) and partial autocorrelation (PACF) correlogram (right) for first difference of time series-White non-Hispanic

Author Contribution A. Habibdoust and M. Tatar: Conceptualization, Methodology, Software, Data curation. A. Habibdoust: Writing—Original draft preparation. A. Habibdoust and M. Tatar: Visualization, Investigation. F. Wilson: Supervision. M. Tatar and F. Wilson: Writing—Reviewing and Editing.

Data Availability The data that support the findings of this study are openly available in Tracking COVID-19 in California website at:, reference number [3].

Code Availability Codes are available on request.

Declarations

Ethics Approval No patients and the public were involved in this research, and the article does not involve human participants and does not contain personal medical information.

Consent to Participate No patients and the public were involved in this research, and the article does not involve human participants and does not contain personal medical information.

Consent for Publication No patients and the public were involved in this research, and the article does not involve human participants and does not contain personal medical information.

Competing Interests The authors declare no competing interests.

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