

# Analysis of Excess Deaths During the COVID-19 Pandemic in the State of Florida

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**Objectives.** To determine the number of excess deaths (i.e., those exceeding historical trends after accounting for COVID-19 deaths) occurring in Florida during the COVID-19 pandemic.

**Methods.** Using seasonal autoregressive integrated moving average time-series modeling and historical mortality trends in Florida, we forecasted monthly deaths from January to September of 2020 in the absence of the pandemic. We compared estimated deaths with monthly recorded total deaths (i.e., all deaths regardless of cause) during the COVID-19 pandemic and deaths only from COVID-19 to measure excess deaths in Florida.

**Results.** Our results suggest that Florida experienced 19 241 (15.5%) excess deaths above historical trends from March to September 2020, including 14 317 COVID-19 deaths and an additional 4924 all-cause, excluding COVID-19, deaths in that period.

**Conclusions.** Total deaths are significantly higher than historical trends in Florida even when accounting for COVID-19–related deaths. The impact of COVID-19 on mortality is significantly greater than the official COVID-19 data suggest. (*Am J Public Health.* 2021;111:704–707. <https://doi.org/10.2105/AJPH.2020.306130>)

The COVID-19 pandemic has spread rapidly throughout the United States, resulting in more than 26 million cases and 440 000 deaths by January 2021.<sup>1</sup> After initially imposing capacity restrictions on businesses and local mask mandates, Florida became one of the first states to relax these restrictions and ban the enforcement of mask mandates. Florida experienced a resurgence of COVID-19 community spread, and, as of January 2021, there have been nearly 1 690 000 cases and 26 479 deaths officially classified as attributable to COVID-19.<sup>1</sup> However, there is evidence that all-cause mortality substantially increased in Florida. For example, the Centers for Disease Control and Prevention (CDC) estimates between 2712 and 7598 excess deaths

were attributed to causes other than COVID-19 in Florida. However, the CDC notes that their estimates were based on provisional and incomplete data.<sup>2</sup>

Although research has focused on officially reported deaths from COVID-19, total deaths caused by the pandemic remain unknown. Therefore, we used COVID-19 mortality data and recorded deaths to compare trends in reported COVID-19–related versus total deaths in Florida using seasonally adjusted time-series modeling.

## METHODS

In this retrospective study, we used historical mortality trends to forecast monthly deaths in 2020 in the absence

of the pandemic. We estimated excess deaths during the pandemic (MMWR 10–39) by subtracting official reported COVID-19 deaths and forecasted monthly deaths from total all-cause recorded deaths from March to September 2020 in Florida.

We used monthly officially reported COVID-19 death data from January to September 2020 provided by the Johns Hopkins University's Coronavirus Resource Center, which compiles data provided by the State of Florida Department of Health based on decedents who tested positive for COVID-19.<sup>1</sup> We used total all-cause recorded deaths from January 2010 to September 2020 from the State of Florida Department of Health, which had the most updated data.<sup>3</sup>

We used seasonal autoregressive integrated moving average (SARIMA) regression modeling with historical mortality trends from 2010 to 2019 to estimate the number of monthly deaths in Florida in 2020 that would have occurred if there had been no COVID-19 pandemic. The SARIMA model uses past values of a time series to predict future points in the series. We followed the Box–Jenkins methodology to construct our model (Appendix [available as a supplement to the online version of this article at <http://www.ajph.org>]). We divided the data into 2 data sets for training (2010–2018) and testing (2019) for in-sample forecasting. We selected the SARIMA model because it provided the best fit to the data and had a high level of forecasting accuracy. We used Stata SE, version 15.1 (StataCorp LP, College Station, TX) for all analyses.

## RESULTS

We selected a SARIMA(1, 1, (1)(0, 1, 1), 12), as it provided the best fit to the data based on multiple criteria (Tables A and B [available as a supplement to the online version of this article at

<http://www.ajph.org>]) and offered high forecasting accuracy (Tables C and D [available as a supplement to the online version of this article at <http://www.ajph.org>]). Predicted deaths from SARIMA modeling of historical trends shown in Table 1 suggest that total all-cause deaths were higher than expected for each month from March to September.

In July 2020, recorded deaths (23 958) exceeded predicted counts (17 643) by 6315 excess deaths, of which 3338 (52.9%) were attributed to COVID-19. This implies an undercount of 2977 for publicly reported COVID-19–related deaths in July. In August 2020, recorded deaths (23 537) exceeded predicted counts (17 046) by 6491 excess deaths, of which 4344 (66.9%) were attributed to COVID-19. In other words, 2147 deaths were undercounted compared with publicly reported COVID-19–related deaths in August. In September 2020, 2130 deaths were attributed to COVID-19, and recorded deaths (19 493) exceeded predicted counts (16 573) by 2920 excess deaths. Before July, the estimated change in all-cause, excluding COVID-19, deaths fluctuated between –376 and 394. For the entire period from

March to September 2020, we estimated 19 241 (15.5%) excess deaths versus historical, prepandemic deaths. During the pandemic, there have been 14 317 COVID-19 deaths. Our analysis suggests that total deaths increased above historical trends, resulting in an additional 4924 all-cause, excluding COVID-19, deaths (Figure A [available as a supplement to the online version of this article at <http://www.ajph.org>])

## DISCUSSION

We found that Florida experienced 19 241 excess deaths from March to September 2020. Also, in the absence of the pandemic, total deaths in Florida would have been 26.4% (or 6315 deaths) and 27.6% (or 6491 deaths) lower in July and August, respectively. Official COVID-19 deaths account for 14 317 of these deaths; however, approximately 5000 excess deaths are unexplained.

The COVID-19 pandemic has had a major impact on population health, resulting in stay-at-home orders, school and business closures, and other public health policies to mitigate community spread. However, there has been

**TABLE 1— SARIMA Model Results for Predicted Deaths, Total Recorded Deaths, and COVID-19-Related Deaths: Florida, 2020**

Deaths	March	April	May	June	July	August	September	Total
Total all-cause recorded deaths, no.	19 683	19 209	19 095	18 803	23 958	23 537	19 493	143 778
SARIMA predicted deaths based on Pre-COVID-19 data, no.	19 204	18 402	18 335	17 334	17 643	17 046	16 573	124 537
Excess deaths								
No.	479	807	760	1 469	6 315	6 491	2 920	19 241
%	2.5	4.4	4.1	8.5	35.8	38.1	17.6	15.5
Official reported COVID-19 deaths								
No.	85	1 183	1 183	1 054	3 338	4 344	3 130	14 317
%	17.7	146.6	155.7	71.7	52.9	66.9	107.2	74.4
Estimated change in all-cause, excluding COVID-19, deaths	394	–376	–423	415	2 977	2 147	–210	4 924

Note. SARIMA = seasonal autoregressive integrated moving average.

speculation on whether deaths from non-COVID-19 causes have decreased or increased during the pandemic. It has been reported that deaths from unintentional injury decreased as a result of lockdown measures, but deaths from chronic disease, drug overdoses, and suicides have increased.<sup>4,5</sup>

Florida was chosen for our analysis because COVID-19 disproportionately affected the state's population, and, historically, it has one of the highest numbers of influenza or pneumonia mortalities in the United States.<sup>6,7</sup> On May 4, Florida was among the first states (along with Texas and Arizona) to begin lifting COVID-19-related restrictions.<sup>8</sup> Additionally, local governments were prohibited from imposing fines on individuals for not wearing face coverings. There was also increasing controversy regarding the accuracy of the officially reported number of COVID-19 deaths.<sup>9</sup> Our SARIMA estimates suggest a surge of all-cause, excluding COVID-19, deaths from June to September, averaging 4666 deaths per month compared with a monthly average of 682 deaths from March to May.

Previous research indicates that excess deaths during the pandemic have been substantial.<sup>10–12</sup> In a study of deaths from March 1 to May 30, the authors reported that excess all-cause deaths were 28% higher than official COVID-19 deaths.<sup>11</sup> For Florida, a separate study<sup>12</sup> reported 966 excess deaths from causes other than COVID-19 between March 1 to April 25, and the corresponding CDC estimates ranged from 2712 to 7598 for February through September.<sup>2</sup> This compares to our estimates of –405 excess deaths in March and April, and 4924 excess deaths from March to September from causes other than COVID-19. Thus, our estimates were conservative during the period in Florida when COVID-19 restrictions

were implemented but increased substantially after May, when these restrictions were relaxed. Our estimates are within the CDC's range of estimates. However, we used a longer data series for mortality data (2010–2020) than did the CDC (2013–2020). Our SARIMA model adjusted for seasonality in the monthly mortality data (mortality increases in the winter months) and had strong goodness of fit to the data.

This study had some limitations. In January 2018, an exceptionally high number of deaths associated with influenza and pneumonia occurred in Florida. This may have affected the SARIMA model estimates. However, we believe our predictions are likely to be conservative as a result. Second, our analysis was restricted to Florida and may not generalize to other states. Finally, we are unable to stratify excess deaths by cause in our data.

Our findings suggest that all-cause deaths may be higher than the reported COVID-19 deaths and historical deaths in Florida based on mortality data since 2010. Thus, the mortality burden of COVID-19 is significantly higher than what the official tally suggests. Examination of excess deaths during the pandemic requires greater attention to aid efforts to reduce the impact of COVID-19 on population health. **AJPH**

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## CONTRIBUTORS

M. Tatar and A. Habibdoust performed the statistical analyses and had full access to all study data; they take responsibility for data integrity and data analysis accuracy. M. Tatar and F. A. Wilson provided administrative, technical, and material support. All authors contributed to concept and design, provided data acquisition and interpretation, drafted the brief, and critically revised the brief for important intellectual content.

## CONFLICTS OF INTEREST

The authors have no conflicts to declare nor financial disclosures to report.

## HUMAN PARTICIPANT PROTECTION

No protocol approval was necessary because no human participants were involved in this study.

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