Application of the ARIMA Model to Forecast Future Overdose Deaths

INTRODUCTION

- Nearly 841,000 people have died since 1999 from drug overdoses, and over 70% of drug overdose deaths in 2019 involved opioids. [1] Evaluating trends in drug overdoses is key for decisions regarding distribution of resources, locations of treatment centers, funding for overdose prevention initiatives, and evaluation of existing legal policies (Blanco et al, 2021).[2]
- Barriers in data processing and quality control, create a lag in time from collection of data to availability of data, making the data to inform public policy 1-2 years old. This impedes the creation of policies to address real-time needs.[2]

There is a need for a predictive model that can accurately trend fatal drug overdoses and provide a baseline for states to implement evidence-based preventative policies

- Impact-oriented modeling helps guide healthcare officials, policymakers, and the general public to make informed behavioral health decisions and capture the potential magnitude and directionality of the opioid epidemic to influence public policy.[3]

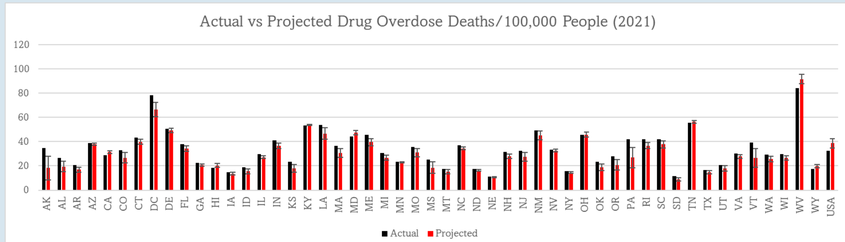
METHODS

The Autoregressive Integrated Moving Average (ARIMA) model is a linear regression model that forecasts future values based on past values of a given time series.

- Drug overdose mortality statistics were collected from the Center for Disease Control and Prevention (CDC)'s National Center for Health Statistics through the Vital Statistics Rapid Release (VSSR)
- Total population data was collected from the United States Census Bureau for 50 U.S. states and the District of Columbia (52 total models. The most predictive ARIMA parameters for forecasting overdose deaths for each state was determined.
- The number of projected deaths for each territory was combined with yearly United States Census Bureau population data for each corresponding territory to produce an overdose death rate, calculated as the number of overdose deaths per 100,000 residents.
- The projected values were then compared to actual released CDC 2021 data and a root-mean-square error (RMSE) was calculated.

RESULTS

Figure 1. Comparison of ARIMA model projections and actual drug overdose death rate per 100,000 people in the United States in 2021



The ARIMA forecasts predict increasing overdose deaths in the United States and most U.S. States, with some states experiencing a near-doubling of overdose deaths from 2020 to 2022.

Overall, the U.S. had 107,521 actual deaths and 128,093.2 projected deaths in 2021, and a projected 179,889.8033 deaths in 2022.

The RMSE of the ARIMA model projections for the U.S. monthly death projections rate was found to be 3.8.

A live version of the model can be found at treatoud.org. For more information, visit www.getwaivered.com

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CONCLUSION

This work represents a preliminary yet invaluable step toward forecasting overdose deaths in real-time on a state-by-state level to measure the efficacy of evidence-based policy for addressing this public health crisis.

This model can be used to

- Monitor overdose deaths
- Evaluate effectiveness of public health interventions, both efficiently and reliably, in a daily or monthly forecast.
- Guide public policy for state and federal governments

Overall, the ARIMA model overestimated overdose deaths compared to the actual deaths released by the CDC and logistic regression. This may be because time series modeling approaches make predictions based on trends in historical data, and therefore are not always efficient in predicting quick or unanticipated changes in data trends.

Future studies will focus on

- Further statistical comparison of predictions from the ARIMA model with existing CDC data as it becomes available
- Comparison with other prediction models to further evaluate the accuracy of this method.

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