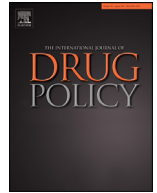




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Research Paper

COVID-19 economic impact payments and opioid overdose deaths

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ABSTRACT

Background: Given the global economic recessions mediated by the COVID-19 pandemic and that many countries have implemented direct income support programs, we investigated the timing of the COVID-19 economic impact payments and opioid overdose deaths.

Methods: A longitudinal, observational study design that included data from the Ohio Department of Health was utilized. Statistical change point analyses were conducted to identify significant changes in weekly number of opioid overdose deaths from January 1 of 2018 to August 1 of 2020. Additional analyses including difference-in-difference, time series tests, interrupted time series regression analysis and Granger causality test were performed.

Results: A single change point was identified and occurred at week 16, 2020. For 2020, the median opioid overdose deaths numbers for weeks 1–16 and weeks 17–32 were 68.5 and 101, respectively. The opioid overdose deaths numbers from weeks 17–32 of 2020 were significantly higher than those in weeks 1–16 of 2020 and those in 2018 and 2019 (before and after week 16). The interrupted time series regression analysis indicated more than 203 deaths weekly for weeks 17–32 of 2020 compared to all other weeks. The result of the Granger causality test found that the identified change point (week 16 of 2020) directly influenced the increase in opioid overdose deaths in weeks 17–32 of 2020.

Conclusion: The identified change point may refer to the timing of many factors, not only the economic payments and further research is warranted to investigate the potential relationship between the COVID-19 economic impact payments and overdose deaths.

Introduction

The convergence of the COVID-19 (SARS-CoV-2) pandemic with the opioid epidemic has created a “perfect storm” which has resulted in the historically high levels of drug overdose deaths that have now surpassed 100,000 in a 12 month period in the United States (Centers for Disease Control and Prevention [CDC], 2021). Policy responses to the pandemic have inadvertently resulted in contributing to the exacerbation of the epidemic. During the COVID-19 pandemic, people with opioid use disorder (PWOUD) have been shown to be more susceptible to COVID-19 mediated stressors than the general population, namely, social isolation, loss of income/ housing, reduced availability of harm reduction strategies and decreased access to medication treatment for opioid use disorder (MOUD; Henderson et al., 2021; Holmes et al., 2020). Social isolation increases the likelihood of opioid overdose in part due to the lack of observers to administer naloxone (Volkow, 2020). Further, PWOUD

struggle to meet basic needs and therefore may turn to informal income sources and use of substances in isolation (Henderson et al., 2021). Lack of access to MOUD has further resulted in gaps in maintenance therapy (Narayan et al., 2021). Additionally, the proliferation of clandestinely produced novel fentanyl related compounds has generated synthetic opioids of unknown and dangerous pharmacological and toxicological effects (Grebely, Cerda, & Rhodes, 2020).

The most susceptible socioeconomic group to drug overdose are low income middle aged, white, men (Altekruse, Cosgrove, Altekruse, Jenkins, & Blanco, 2020). Further, numerous news reports have suggested a link between the COVID-19 economic impact payments (“stimulus checks”) and opioid overdose deaths. The link between the timing of assistance payments and drug overdose deaths reflects a phenomenon known as the “check effect”. The check effect has been associated with higher numbers of drug overdose deaths, hospital admissions and 911 calls in the days and weeks associated with income assistance payments

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(Dobkin & Puller, 2007; Goedel, Green, Viner-Brown, Rich, & Marshall, 2019; Otterstatter, Amlani, Guan, Richardson, & Buxton, 2016; Phillips, Christenfeld, & Ryan, 1999; Richardson, Dong, Kerr, Milloy, & Hayashi, 2021; Riddell & Riddell, 2006; Zlotorzynska et al., 2014). Individuals in low income socioeconomic groups are most susceptible to drug overdose and most likely to receive government assistance payments (Case & Deaton, 2015). Although these government provided income assistance payments are intended to pay for basic needs, it may actually be facilitating a cyclic pattern of substance use and increased overdose deaths (Shaner et al., 1995). The lack of basic needs has placed an increase burden on PWOUD which has contributed to their dangerous use of substances in isolation (Henderson et al., 2021). Here, we set to investigate the timing of the COVID-19 economic impact payments and the increases in opioid overdose deaths that have been reported during the COVID-19 pandemic (Vieson, Yeh, Lan, & Sprague, 2021).

Methods

This longitudinal, observational study included data from the records obtained from the Ohio Department of Health (ODH). The ODH data base was quarried in the following fashion. ODH manages the Ohio Public Health Information Warehouse. The current study examined the Mortality dataset for deaths in Ohio related to opioids. Mortality information is collected by ODH and is derived from Ohio Certificates of Death. Statistical change point analyses were conducted to identify significant changes in trends in the weekly opioid overdose death numbers from January 1 of 2018 (week 1, 2018) to August 1 of 2020 (week 32, 2020). These analyses were implemented in R with changepoint package with PELT methods.

Several analyses were conducted to determine and identify potential changed patterns in weekly opioid overdose deaths numbers, and the impact on the timing of the identified changed point. Without any pre-conception of whether there is a time point that may contribute to a significant change in the weekly overdose deaths numbers, and, if so, when that time point occurs, a change-point analysis of the weekly opioid overdose deaths from week 1 of 2018 to week 32 of 2020 was first conducted. Given the identified change point, a difference-in-difference (DID) analysis was carried out to test the difference in weekly opioid overdose deaths numbers in 2020 before and after the identified change point. To evaluate the changes in weekly opioid overdose deaths before and after the identified change point, an interrupted time series regression analysis was carried out (Bernal, Cummins, & Gasparrini, 2017). The model is specified as $Y_t = \beta_0 + \beta_1 T + \beta_2 X_t + \beta_3 T X_t$, where Y_t is the weekly opioid overdose death at time t , T is the time, and X_t is an indicator function whose value is 0 for weeks prior to week 17 of 2020, and 1 for weeks 17–32 of 2020. Furthermore, the patterns of the opioid overdose deaths numbers of the entire study period were further analyzed using Poisson regression model, treating the weekly opioid overdose deaths numbers as dependent variable, and week (categorical with 52 levels representing 52 weeks), year (categorical with 3 levels representing 2018, 2019 and 2020) and the change point (week 1–16 = no, > week 16 = yes) as explanatory variables. Main effects and two-way interactions were considered, and effects were removed if $p > .05$. Of interest is the interaction between year and change point, as it indicates, if significant, the difference of weekly opioid overdose deaths before and after change point is dependent of the year. To identify where the significant differences occur, multiple comparison tests testing pairwise differences were conducted while controlling the family error rate. To further test the causality effect of the identified change point, an autoregressive model with an exogenous variable representing the timing of the identified change point (ARX model) was conducted. A Granger causality was then applied to the time series model to test whether or not the timing of the identified change point was causally linked to increased opioid overdose deaths numbers (Otterstatter et al., 2016). It should be noted that significant Granger causality test does not indicate causality, but rather a direct influence of one variable on another

(Barrett & Barnett, 2013). A significant test in our study would indicate that the identified change point is predictive of a temporal increase in opioid overdose deaths, not simply a happenstance in time.

Results

The statistical change point analyses identified a sole change point which occurred at the week ending in April 18, 2020 (week 16, 2020), with a $p < .001$ (Fig. 1). There is an observable upward trend in the opioid overdose deaths number starting at week 17, 2020. The 2020 economic impact payments were also initiated during week 17, 2020. For 2020, the median opioid overdose deaths numbers for weeks 1–16 and weeks 17–32 were 68.5 and 101, respectively. For the period weeks 1–16, the median opioid overdose deaths numbers were 60 and 64, respectively, for 2018 and 2019.

The DID analysis of the median opioid overdose deaths numbers shows that the median opioid overdose deaths numbers for weeks 1–16 and weeks 17–32 of 2020 were significantly different (p -value < 0.001 , Table 1). The interrupted time series regression analysis indicated that on average there were more than 203 deaths weekly for weeks 17–32 of 2020 than all the weeks from week 1 of 2018 to week 16 of 2020 (Table 2). The Poisson regression model further demonstrates that the interaction between change point (week 17) and year was significant (p -value < 0.001 , Table 3). Post-hoc multiple pairwise comparison tests (Duncan's test) show that significant differences exist mainly between weeks 17–32 of 2020 and any other time periods (pre- or post-week 16) in 2018, 2019 and 2020 (Fig. 2). The Granger causality test with week 17 of 2020 as the exogenous variable for the timing of the COVID-19 economic impact payments was significant ($p < .001$), indicating that the timing was linked to the observed increase in opioid overdose deaths after week 16 of 2020.

Discussion

Compared to 2018 and 2019, a significant increase in the number of opioid overdose deaths was observed during weeks 17–32 of 2020. The 17–32 week timeframe represents the period in which the first round of economic impact payments were provided. Payments were initially dispersed to individuals making less than \$10,000, followed by those making between \$10,000 and \$98,000 (Friedman, 2020). In the United States, the Coronavirus Aid, Relief, and Economic Security Act (CARES Act) of 2020 provided individuals with personal annual incomes of \$75,000 or less, a single payment of \$1200 (\$2400 for eligible individuals filing a joint tax return), plus \$500 per qualifying child (Internal Revenue Service, 2021). During the first round of economic impact payments, a total 6,118,555 payments were made to Ohioans totaling \$10,202,015,184 (Internal Revenue Service, 2020).

The total number of opioid overdose deaths were highest in the first six weeks of the first round of economic impact payments. The result of the Granger causality test found that the identified change point influenced the increase in opioid overdose deaths in weeks 17–32 of 2020. However, this is not to say this is the only contributing factor to the increase in opioid overdoses during the COVID-19 pandemic. The overall health of people who use drugs has been described as a matter of intersecting “complex adaptive systems” during the COVID-19 pandemic (Grebely et al., 2020). The intersecting complex adaptive systems includes not only economics but also social, cultural, political and policy effects on health.

The findings of an association with the timing of the first round of economic impact payments from the current study are consistent with previous studies. In the United States, Shaner et al., first described the “check effect” as a peak in cocaine use, psychiatric symptoms and hospital admissions shortly following disability payments (Shaner et al., 1995). These findings lead those authors to suggest that disability payments may have created a “government-sponsored revolving door”. In the Canadian city of Vancouver, Riddell and Riddell (2006) reported an

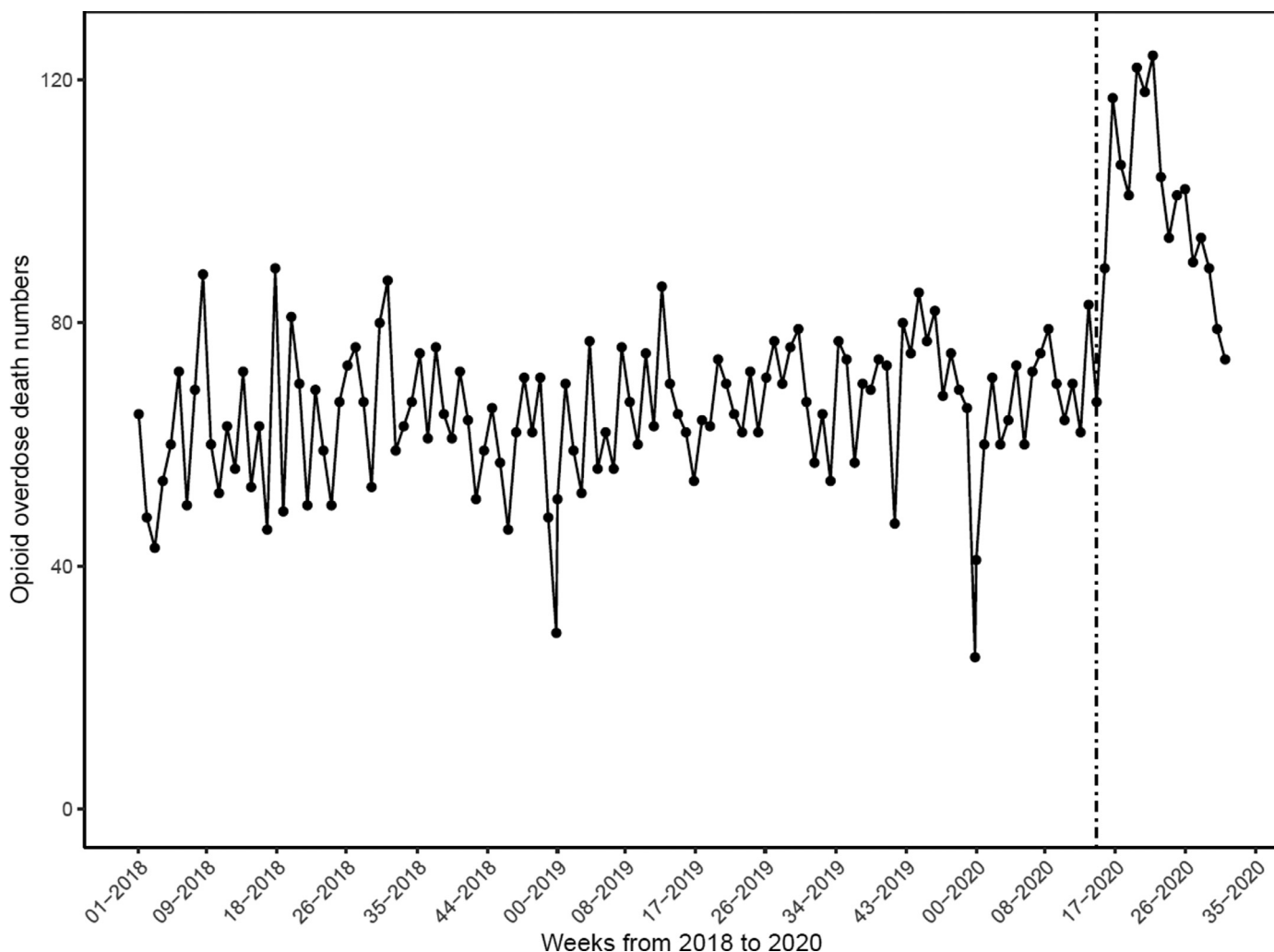


Fig. 1. Weekly opioid overdose deaths from the first week of 2018 to week 32 of 2020 in Ohio. Change point analyses identified week 16 of 2020 as the only change point ($p < .001$) indicated by the vertical dashed line.

Table 1
Weekly median opioid overdose deaths for weeks 1–16 and 17–32.

Weeks 1–16		2018	2019	2020
Median OOD #		60	64	68.5
Weeks 17–32		2018	2019	2020
Median OOD #		68	68.5	101
DID Analysis of 2020 OOD				
Median DID OOD #	Weeks 1–16	Weeks 17–32	95% CI	p-value
	-8.167	29.67	(-46.33 –27.33)	< 0.001

increase in the number of overdose admissions on the three days beginning with check day relative to the other days of the month. These findings were subsequently confirmed by Zlotorzynska et al. (2014), who found that there was a significant association between the rate

of non-fatal overdoses and the issuing of income assistance checks in Vancouver. In British Columbia, Otterstatter et al. (2016) reported that the weekly mortality due to drug overdose was 40% higher during the weeks of income assistance payments compared to the other

Table 2
Interrupted time series regression analysis.

Coefficient	Estimate	Standard Error	p-value
β_0	61.271	2.041	< 0.001
β_1	0.062	0.029	.033
β_2	264.126	79.358	.001
β_3	-1.778	0.608	.004

Table 3
Analysis of deviance table of poisson regression.

Variables	DF	Deviance	p-value
Year	2	135.00	< 0.001
Change Point	1	54.45	< 0.001
Week	51	154.01	< 0.001
Year x Change Point	2	48.62	< 0.001

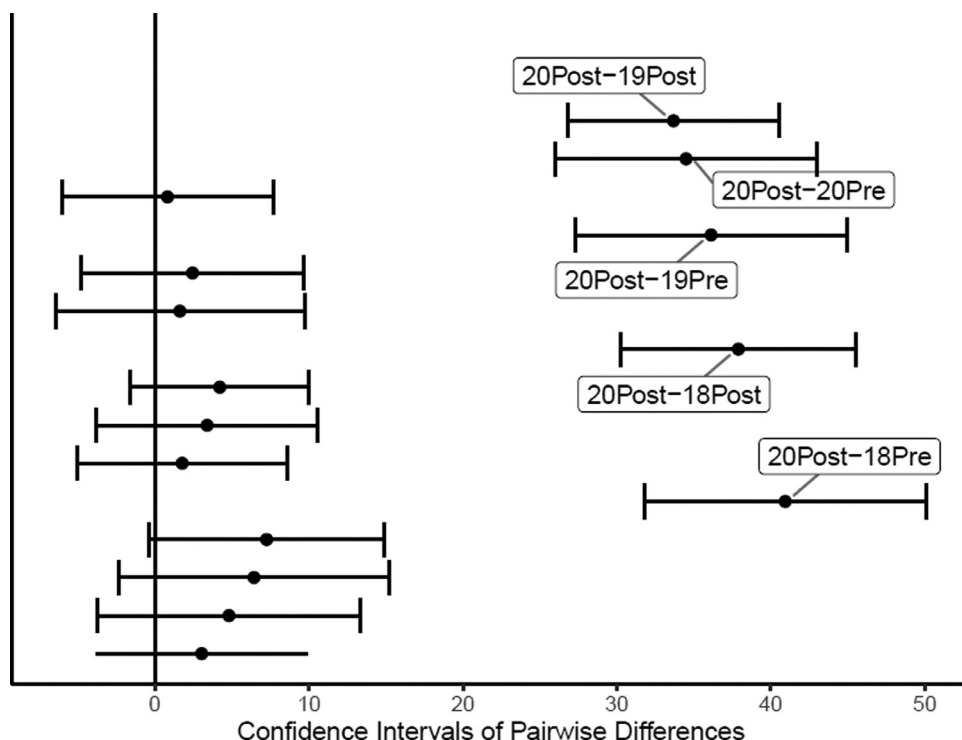


Fig. 2. Post-hoc confidence intervals of pairwise mean differences (family error rate = 0.05).

weeks. [Watson, Guettabi, and Reimer \(2020\)](#) found a 14% increase in substance-abuse incidents the day after the Alaska’s Permanent Fund Dividend payment and a 10% increase over the following four weeks. Regarding the economic impact payments, [Tsai, Huang, Rajan, and Elbogen \(2021\)](#) found that those that first received the economic impact payment during the COVID-19 pandemic had a significantly increased use of any illicit drug in the past month. When taken into consideration with the previously identified COVID-19 policy impact on PWOUD such as social isolation, loss of income/ housing, reduced availability of harm reduction strategies and decreased access to MOUD ([Henderson et al., 2021](#)), the sudden infusion of economic resources created by the economic impact payments may have also played a contributing role in the exacerbation of the opioid epidemic.

Limitations of this study include a lack of data on the income and other social-economic characteristics of those that died from opioid overdose deaths. Although the COVID-19 lockdown restrictions were consistent throughout the state of Ohio, the lack of consistency in other states may limit the generalizability of these findings. Multiple factors associated with the lockdowns (e.g. social isolation, unemployment, etc.) would have also contributed to the number of opioid overdose deaths and the findings from this analysis do not provide a direct causal link. Unfortunately, the internal revenue service was not able to provide specifics on the weekly distribution of income payments. Another limitation of this study is that the cohort is limited to an analysis of those with an observed opioid overdose death and there are no data in the ODH database on those who did have an overdose death but were classified as unrelated to opioids or misclassified as a death from other causes.

There are several policy implications to be reflected upon when the results of the present study are taken into consideration with other COVID-19 related policy changes. Stay at home orders and social distancing policies increase the risk of social isolation ([Henry et al., 2020](#)). Social isolation has been suggested to potentiate mental health issues and subsequently the risk of opioid overdose ([Ataiants, Roth, Mazzella, & Lankenau, 2020](#)). The negative consequences of social isolation is compounded by PWOUD having higher rates of mental health issues

([Williams, Girdler, Williams, & Cromeens, 2020](#)). Some recent studies have suggested that a reduction in health and harm reduction services and an increase in unsafe forms of fentanyl may have also contributed to the increase in drug use and overdose during the COVID-19 pandemic ([Grebely et al., 2020](#)). Two different world-wide studies have demonstrated a nearly 60% decrease in the availability in drug treatment for people who use drugs ([CREW, 2020](#); [EMCDDA, 2020](#)). The COVID-19 pandemic has resulted in some adaptive strategies to improve access to buprenorphine and methadone and to increase opportunities for take-home doses of these drugs ([Del Pozo & Beletsky, 2020](#)). Synthetic forms of fentanyl that lack clinical evaluation have also contributed to the increase in opioid deaths ([Tyndall, 2020](#)). In Ohio, there was a significant increase in opioid overdose death rate from first quarter to second quarter of 2020. The poisoning indicator fentanyl was present in 94% of cases during the second quarter of 2020 ([Vieson et al., 2021](#)). [Tyndall \(2020\)](#) suggested that strategies should be considered to create venues for access to safe drug supply. COVID-19 has also reduced the availability of naloxone as a harm reduction strategy for the prevention of opioid overdose deaths ([Collins, 2021](#)). [Collins \(2021\)](#) recommend the implementation of strategies to reduce the regulatory barriers that have attenuated the community-based naloxone distribution.

In their review of the treatment disruptions in OUD associated with COVID-19 pandemic measures, [Henderson et al. \(2021\)](#) clearly and succinctly make the case for public policy makers to adequately predict and anticipate the negative consequences of public health measures implemented in future pandemics and not to only focus on one crisis at a time. [Del Pozo and Beletsky \(2020\)](#) suggest that the COVID-19 pandemic has created an opportunity for innovative and adaptive public health and drug policy. As these new policies are implemented, all factors that have contributed to the “perfect storm” created by the intersection of the COVID-19 pandemic and the opioid epidemic need to be taken into consideration. Given the multifactorial nature of the opioid epidemic, the results of our analyses warrant further investigations into the potential link between COVID-19 economic impact payments and the increases in opioid overdose deaths seen in 2020.

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Ethics approval

The authors declare that the work reported herein did not require ethics approval because it did not involve animal or human participation.

Declarations of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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