THE DRUG OVERDOSE EPIDEMIC SEEN THROUGH DIFFERENT LENSES

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INTRODUCTION

The COVID-19 pandemic has over-shadowed and diverted public attention away from another on-going, world-wide health crisis --- drug overdoses. The "Big Three" drugs that are most often abused ---opioids, methamphetamines, and cocaine --- caused an estimated 95,000 deaths in the United States in 2018 alone (Cunningham, 2020). Between 2010 and 2018, deaths attributed to drug overdoses surged by 151% in the United States (Merelli, 2020) and opioid abuse by itself accounted for an estimated 67,000 of those deaths (Cunningham, 2020). Put somewhat differently, the age-adjusted death rate (age-adjusted death rates adjust raw death rates for differences in the age distribution of the populations they measure) from drug overdoses per 100,000 individuals rose from 6.8 in 2010 to 17.1 in 2018 (CDC, 2020A). Preliminary reports also suggest a surge in opioid overdose deaths following the onset of the COVID-19 pandemic (CDC, 2020).

The acceleration in drug overdose deaths has attracted the attention of researchers who attempting to provide answers to an obvious albeit complex question --- "Why?" Related research has been profoundly influenced by the work of Case and Deaton (2015, 2017), who introduced the concept of "deaths of despair," who attribute deteriorating economic circumstances along with the absence of hope and optimism as the most important determinants of the rising drug overdose death rate. Interestingly, by contrast, the working paper by Ruhm (2019) estimates that less than 10% of the drug and opioid death rates that has occurred in recent years is attributable to the deaths of despair explanation.

Studies published in medical journals often have adopted a broader approach (Dwyer-Lindgren et al., 2016, 2017, 2018; Monnat, 2018; Shiels et al., 2019, Nosrati et al., 2019). Nosrati et al. are especially insightful because they provide a rigorous analysis of the impacts of

economic decline, crime, incarceration, and education. The present study follows in this same vein except that we expand their framework with several additional hypotheses regarding factors that plausibly may influence drug overdose death rates.

If deaths of despair are not the primary cause of drug overdose deaths, then what are the alternative explanations, and what empirical significance do they have? We utilize data taken from a panel of 94 independent cities and counties in Virginia from 2008 through 2017 to explore the relative importance of deaths of despair versus a number of alternate hypotheses. The city/county perspective has been lacking in many previous studies yet is vital because cities and counties bear substantial responsibility and incur substantial costs when drug overdoses occur.

EMPIRICAL ANALYSIS

Table 1 presents the period fixed-effects semi-log panel regression estimation. The dependent variable is the natural log of the annual drug overdose death rate in the 94 cities and counties. All values for the independent variables are lagged one year to reflect the likely delay between emerging circumstances in the jurisdictions and abusive drug behavior. The *t-1* subscript attached to the independent variables represents this lag. Lagging also helps avoid potential endogeneity problems.

Formally, we estimate the following equation: $\log D_{it} = a + \Sigma\, b_{ijt} X_{ijt-1} + e_{ijt-1}$, where $\log D_{it}$ = the natural log of the drug overdose death rate (D) in city or county "*i*" in year "*t-1*," where a = constant term, b_{ijt-1} = regression coefficient for city or county "*i*" with respect to characteristic "*j*" in year "*t-1*,", X_{ijt-1} = independent explanatory characteristic "*j*" for city or county "*i*" in year "*t-1*," and e_{ijt-1} is the error term. The data sources are provided in the Data Appendix.

Deaths of Despair? Unemployment and Income

The essence of the deaths of despair hypothesis is straightforward: the inability of individuals to find gainful employment and/or to earn an "adequate" income leads them to seek refuge in drugs (Case and Deaton, 2015 and 2017). Overuse and abuse lead to death. We test this reasoning in two ways. First, if not having a job is critical, then holding other things constant, we should find a positive relationship between the drug overdose death rate and the

unemployment rate. Second, if income inadequacy is problematic, there should be a negative relationship between overdose death rates and income.

Table 1 reveals that the estimated coefficient of the unemployment rate variable fails to be statistically significant at the .05 level. Thus, this version of the economic despair hypothesis falls short. Holding other relevant factors constant, the unemployment rate does *not* have a systemic, substantial pattern of influence upon drug overdose death rates.

However, the estimated coefficient on the median household income variable is negative, as the deaths of despair hypothesis suggests, and statistically significant at the .01 level, implying that a higher income diminishes drug overdose death rates. How much? Figure 1 reveals that a 5.0 percent higher median household income is associated with a mere 0.591% reduction in the drug overdose death rate, i.e., although there is evidence in favor of the economic misery/deaths of despair hypothesis, the quantitative impact is *extremely modest*. Indeed, a $10,000 higher median household income in Dickenson County in Southwest Virginia's coal country would have translated to a 33.8% increase in that county's median household income in 2017 --- a huge increase. Nevertheless, Dickenson County's opioid death rate would have fallen from 57.7 to only 57.3. This finding constitutes extremely tepid support at best for the narrative proffered by proponents of the economic misery/deaths of despair hypothesis.

Assertions of the Council of Economic Advisers

The President's Council of Economic Advisers contends that a variety of governments, especially the federal government, have enabled drug abuse by supplying income, by promoting health insurance coverage, and by providing disability status to individuals, some of whom misuse these benefits (Council of Economic Advisers, 2019). The Council refers to such practices as "public subsidies" (Council, at 25) and estimates that the share of prescribed opioids funded by government programs rose from 17% in 2001 to 63% in 2015 (Council, at 35).

We test two aspects of these assertions. First, we include as an explanatory variable the percentage of adults under age 65 who have been awarded some level of disability status and consequently receive an income flow from governmental units. There are huge variations in the level of disability status in our sample. In 2017, for example, Arlington County (suburban Washington DC) recorded a 4.1% adult disability percentage, whereas Lee County (in Southwest Virginia's coal country) exhibited a 26.8% adult disability rate. However, as shown in Table 1,

once one controls for household income, educational attainment, and other factors, the disability rate in a jurisdiction is not a statistically significant predictor of drug overdose death rates.

Second, one of several sources of income cited as possibly problematic by the Council is federal government's Supplementary Nutritional Assistance Program (SNAP), commonly known as "food stamps". Certain media stories argue SNAP coupons are sold or traded for opioids, which leads to abuse (Constable, 2018; Loftsgordon, 2020). A Department of Agriculture study (2017) estimated that $1.1 billion in SNAP coupons were "trafficked" (sold) annually by recipients between 2012 and 2014.

Once again, substantial variation exists inside Virginia jurisdictions with respect to SNAP outlay percentages. In 2017, 2.23% of the population in Washington DC suburban Loudoun County received SNAP coupons, but in coal country's Dickenson County, 39.13% did. The estimated coefficient of the SNAP variable is highly significant statistically and as Figure 1 discloses, a 5-percentage point increase in a jurisdiction's SNAP recipients is associated with a 3.54% increase in the median value of a jurisdiction's drug overdose death rate --- more than a modest reaction.

As background for the finding that every 1% increase in the percentage of SNAP recipients results in a .35% increase in the drug overdose death rate, observe that federal government SNAP payments increased from $14.565 billion in 2000 to $74.851 billion in 2012 and receded to $57.139 billion in 2018 (FRED, 2020e). These are hefty expenditures involving more than 40 million recipients (exceeding 700,000 in Virginia), but the consensus is that they are vitally needed outlays, especially in times of high unemployment (Dean, 2016). Our results suggest, however, that worthy public purposes might be better served by more careful supervision and auditing of the program.

Table 1

Explaining the Natural Log of the Drug Overdose Death Rate, 2008-2017

Variable	Coefficient		t-Statistic	Probability
Constant	-.949862		-2.24	.025[b]
Median HH Income$_{it-1}$	-.00000591		-8.83	.000[a]
Unemployment Rate$_{it-1}$	-.012059		-1.03	.299
Annual Prescriptions Per 100$_{it-1}$	.001416		15.58	.000[a]
Disability Percent Underage 65$_{it-1}$	-.009158		-1.15	.250
Percent of Population Receiving SNAP$_{it-1}$	.054506		8.36	.000[a]
Market Concentration$_{it-1}$	-.005098		-5.92	.000[a]
Percent Completed High School$_{it-1}$	.018466		4.81	.000[a]
Percent Employment in Mining$_{it-1}$	.013707		3.50	.001[a]
Mean Travel Time to Work$_{it-1}$	.035532		9.43	.000[a]
Jail Population Per 1,000$_{it-1}$	.004196		1.83	.068[c]
Percent Population White$_{it-1}$	.001409		18.22	.000[a]
Population Per Square Mile Squared$_{it-1}$	-.0000131		-1.89	.059[c]
Percent Adults Obese$_{it-1}$	.011547		4.28	.000[a]
Percent Adults Who Smoke$_{it-1}$	.013296		5.24	.000[a]

Notes: **The White (1980) cross-section heteroscedasticity correction has been applied. N = 729 total observations from 94 cities and counties. R^2 adj. = .516; F = 38.00 (.0000). a, b, and c indicate statistical significance at the .01, .05, and .10 levels, respectively, in two-tailed tests.**

Healthy Lifestyles

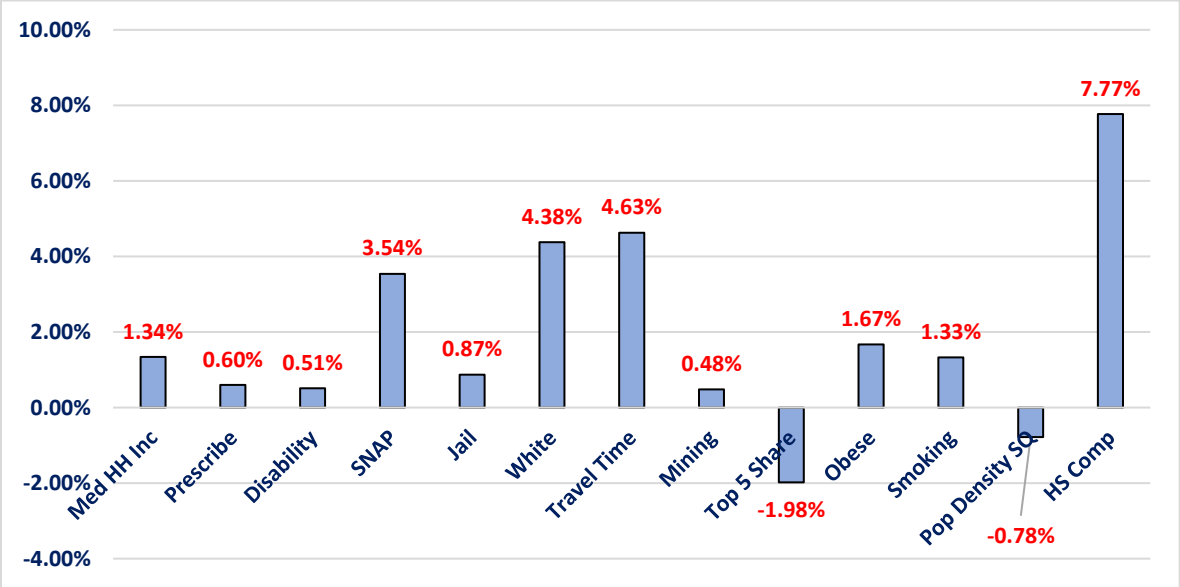
Morbidity and mortality studies clearly establish that deaths, even those attributed to drug overdoses, often have multiple causes. Co-morbidity may exist such that a drug abuser might also be obese, alcoholic, diabetic, and/or smoke. The research literature has acknowledged such possibilities but largely ignores them in multivariate analyses.

County-level morbidity data have been assembled by the Centers for Disease Control and Prevention and presented in highly usable form by the Robert Woods Johnson Foundation (2020). We use their estimates for obesity (*Percent Adults Obese*) and smoking (*Percent Adults Who Smoke*) here as lifestyle control variables. In Table 1, the estimated coefficients of both the obesity and the smoking variables are positive and statistically significant. Thus, it seems possible that they have causal influences on drug overdose death rates. Figure 1 reveals that a 5.0 percentage point increase in the percentage of obese adults s associated with a 1.67% increase in the drug overdose death rate. A comparable 5.0 percentage point increase in the percent of adult smokers is related to a 1.33% increase in the drug overdose death rate.

Implicitly, our findings suggest that measures of community health in addition to obesity and smoking should be addressed in future research.

Figure 1

How Drug Overdose Death Rates Respond to 5.0% Changes in Statistically Significant Variables in 94 Virginia Cities and Counties, 2008-2017



Notes: All estimates are derived from Table 1. Percent changes are absolute, not relative, and therefore a 5.0% increase in obesity refers to an increase from obesity's mean value of 29.0% to 34.0%.

Supply-Side Influences

Opioids can be obtained legally via prescriptions or illegally via many illicit avenues. If the number of legal prescriptions is large and care is not taken to supervise the use and strength of these prescriptions, then larger volumes of prescriptions might lead to increased drug overdose deaths. We test this proposition by including an explanatory variable that measures the annual number of prescriptions written per 100 individuals. The simple unweighted average for the annual number of prescriptions written annually per 100 people in the cities and counties over the ten years was 90.68 but varied between a low of 3.8 for Dinwiddie County in 2017 to a high of 583.3 for the City of Martinsville in 2011.

Table 1 reveals that variations in prescribing rates are a statistically significant predictor of drug abuse death rates. However, Figure 1 informs us that a 5.0 percent increase in the annual

number of prescriptions (this translates to about 4 in number) increases the drug abuse death rate, but only by 0.60%.

Another supply-side influence is quantitatively more important --- the market share of the five pharmacies supplying the most opioid pills in each jurisdiction. Here, a 5.0 percentage point increase in the median market share of the largest pharmacies generates a 1.98% decline in the drug overdose death rate (Figure 1). Arguably, this occurs because it is more difficult for drug abusers to "game" the system when they must deal with larger (often chain) pharmacies that keep digital track of their prescription activities, regardless of location.

Education

The role of formal education vis-à-vis focused drug education and drug abuse has always been contested; however, there is limited evidence that additional formal/traditional education frequently is correlated with drug abuse. Cocaine, for example, once was perceived to be a rich man's drug, and such well-educated individuals as Sigmund Freud and Thomas Edison were cocaine users. Schepis et al. (2018) found the usage rates of stimulants were highest among full-time college students and college graduates. We supply additional evidence on this issue and do so by specifying the education variable as the percentage of adults age 25 years and older who have earned at least a high school diploma. Case and Deaton (2015, 2017, 2020) argue that the lack of formal education leads to drug abuse. Their formal education metric was whether an individual has earned a bachelor's degree or more. Our view is that a more pertinent measure of formal education (one more closely linked to the realities of labor markets in non-urban areas) is whether an individual has earned a high school diploma. In many Virginia locales, a college degree is not essential to employment, but a high school diploma is because it symbolizes a variety of desired employee characteristics, including the ability to read, perform at least elementary computations, follow directions, and persist at work-related tasks.

In any case, the positive, statistically significant estimated coefficient on the high school graduation variable in Table 1 suggests that additional formal education is associated with increased drug abuse and deaths. Figure 1 demonstrates that a 5.0 percent increase in the median percentage of high school graduates in a jurisdiction leads to a large 7.77% increase in the drug abuse death rate.

Travel Time to Work

Joblessness frequently is cited as a vital negative element in the deaths of despair scenario. However, jobs may exist but not be available nearby. Commuting may be required, and commuting can be time-consuming, expensive, and physically and emotionally stressful, potentially increasing drug abuse. We find strong evidence of such a phenomenon. Not only is the estimated coefficient of the variable measuring the average mean number of commuting minutes statistically significant (prob. = .0000), but as Table 1 and Figure 1 reveal, a 5 percent increase in mean commuting time (approximately 1.3 minutes) is associated with a 4.63% increase in the drug abuse death rate. There is a potentially important relationship here, albeit one that has heretofore been neglected in published research.

Riskier Employment

Certain forms of employment involve a higher degree of workplace risk in terms of injury or death. Active employment in an industry such as mining carries multiple health risks, including physical injuries such as broken arms and legs and lung and cardiac illnesses resulting from debris and coal dust (Landen et al., 2011; Laney and Weissman, 2014; NORC, 2020b). To the extent that greater injury and health risks are associated with mining employment and thereby result in pain and discomfort of one form or another and/or in emotional depression, greater use of opioids may emerge as a coping mechanism. We cannot measure all forms of employment risk in all industries, but historically Virginia has been one of the top 10 coal-producing states (United States Energy Information Administration, 2020). We measure the extent of this risky activity by the variable *Mining Employment Risk* (*MINING*), the percent of total employment engaged in mining in each jurisdiction. As shown in Table 1, the estimated coefficient on this variable is highly statistically significant (prob. = .0010). Furthermore, based on Table 1 and reflected in Figure 1, a five-percentage point higher employment rate in mining is associated with a nearly a 7.0% greater opioid death rate.

Racial and Ethnic Considerations

Some regard drug and opioid abuse as a "White problem" (Hansen and Netherland, 2016; NPR, 2017), and it is true that individuals who self-identify as White accounted for 75.6 percent of all those who died from opioid abuse in 2018 (Kaiser Foundation, 2020). Table 1 provides some support for the whiteness hypothesis. The estimated coefficient of the "White" variable is highly statistically significant (prob. = 0.0000). Interestingly, across a variety of estimations, no

other racial or ethnic indicator achieved statistical significance. In any case, Figure 1 tells us that a 5.0 percentage point increase in this measure of "Whiteness" is associated with a 4.38% increase in the drug overdose death rate. Nevertheless, we also note that there is some evidence that the drug overdose death rate gap between Whites and other racial and ethnic groups has been narrowing recently (CDC, 2019).

Law Enforcement

Calls for enhanced law enforcement, more and longer prison sentences, and abolition of parole were popular planks in many political platforms in the 1980s and 1990s. This led to the building of additional prisons and the sentencing of more individuals to jail. Moreover, drug-related convictions often have resulted in longer prison terms for violators. The United States now has the highest incarceration rate of any developed country in the world (MacArthur Foundation, 2020).

A relevant question, however, is whether this strategy has worked. There is growing bipartisan agreement that it has not (for example, MacArthur Foundation, 2020). We provide further evidence of this in Table 1, where the estimated coefficient of the "jail" variable (the number of individuals per 1,000 in jail in a jurisdiction) is both positive and highly significant statistically. We find no evidence that jail sentences deter individuals who abuse drugs and ultimately die from overdoses. Indeed, the opposite may well hold true (prob. = .068), with a 5.0 percent absolute *increase* in the incarceration rate in a jurisdiction being associated with a 0.87% *increase* in the drug overdose death rate. This result is consistent with the findings of Nosrati et al. (2019, p. 1087), who observe that "Extensive evidence has linked incarceration to various factors that are associated with drug overdose deaths, including stigma, family disruption, and neighborhood decline."

The Urban/Rural Hypothesis

Some contend that drug overdoses are predominantly a rural phenomenon (Dwyer-Lindgren et al., 2017; Monnat, 2018); Shields et al., 2019); Oppel, 2019), but our findings provide only modest support for this point of view. Our measure of "ruralness" is each jurisdiction's population per square mile squared. While the estimated coefficient of this variable is negative (implying that lower population density --- greater ruralness --- pushes drug overdose death rates upward), it is not compelling in that it is not quite statistically significant at

the 5 percent level (prob. = .059). In any case, a 5.0 percentage point increase in our population density variable is weakly associated with only a 0.78% decline in drug overdose death rates.

CONCLUSIONS

We explore new ground by adopting a broad, multidisciplinary view of the statistical determinants of drug overdose death rates. We consider the influences of economic, social, medical/health, and governmental factors. We find that the drug overdose mortality rate is an increasing function of the percentage of adults who smoke, the percentage of adults who are obese, the simple unweighted average annual number of prescriptions written annually per 100 people, the percent of the population that is White, the percent of the population incarcerated, the percent of the population receiving SNAP benefits, the percent of the adult population with at least a high school diploma, the percent of the population employed in mining, and mean travel time to work. Furthermore, the drug overdose death rate is a decreasing function of median household income, population density, and the degree of market concentration of legal drugs providers.

Thus, we conclude that while the "deaths of despair" hypothesis has some empirical validity, its quantitative impact is small; hence, it accordingly deserves far less attention and weight than it has been receiving. On the other hand, we find that previously ignored factors such as commuting time, local pharmacy market structures, including prescription practices, and the prevalence of SNAP payments do make a difference in drug overdose death rates. Among the policy conclusions to be inferred here is the need to monitor drug prescription practices more closely, which is consistent with Hadland, Krieger, and Marshall (2017).

Finally, we may ask: How do phenomena such as COVID-19 and alcoholism affect opioid overdose death rates? The answer is, unsurprisingly, we do not yet know. The data we have used in this study consist of annual observations of cities and counties in Virginia. Fortuitously, the Overdose Detection Mapping Application Program (ODMAP) has been collecting real time opioid incident data from participating law enforcement and health organizations in Virginia. These data, when made public, will provide means for researchers to investigate whether there exist connections between opioid overdose death rates and COVID-19.

Meanwhile, alcohol consumption is up 14% during a period beginning in late May 2020 and extending into June 2020 (JAMA Network, 2020). Does this mean that alcohol abusers are more likely to become drug abusers? Perhaps, but this connection remains to be established. However, the National Institute on Alcohol Abuse and Alcoholism (2020) opines that "alcohol has the potential to further complicate the COVID-19 pandemic in multiple ways." Extensive use of alcohol weakens the immune system and therefore making the contraction of COVID-19 more likely (Livingston, 2020). Will these circumstances translate to a greater opioid death rate? Simultaneously, COVID-19 also has caused the economy to contract, and unemployment rates have spiked upwards while generating increased social isolation. Will these adverse circumstances invigorate the economic misery/deaths of despair narrative? Future research has many avenues to explore.

DATA APPENDIX

Median Household Income: Federal Reserve Bank of St. Louis (FRED), "Median Household Income," https://fred.stlouisfred.org.

Annual Prescriptions per 100 People: Centers for Disease Control and Prevention (CDC), www.cdc.gov/drugoverdose/maps/rxcounty2015.html.

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Percent of Individuals Age 25+ Who Have Completed High School or More: United States Census, Quick Facts, various years, https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.

Percent of Employment in Mining: NORC, https://opioidmisusetool.norc.org.

Mean Travel Time to Work: United States Census, Quick Facts, various years, https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t.
Jail Population per 1,000 Individuals: VERA, http://trends.vera.org/incarceration-rates?data=localJail.

Percent of the Population That Self-Classifies as White: VERA, http://trends.vera.org/incarceration-rates?data=localJail.

Population Per Square Mile: FRED, https://fred.stlouisfred.org for resident populations and United States Census, Quick Facts, various years, https://factfinder.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t for the areas of jurisdictions.

Percent Adults 18+ Years Who Are Obese: Robert Woods Johnson Foundation, "County Health Rankings & Roadmaps," www.countyhealthrankings.org/explore-health-rankings.

Percent Adults 18+ Years Who Smoke: Robert Woods Johnson Foundation, "County Health Rankings & Roadmaps," www.countyhealthrankings.org/explore-health-rankings.

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