



RESEARCH ARTICLE

Factors Related to Drug Overdose Deaths in Ohio

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Submitted March 19, 2022 Accepted February 8, 2023 Published April 17, 2023 <https://doi.org/10.18061/ojph.v5i2.8885>

ABSTRACT

Background: Drug overdoses have had a devastating impact on public health in Ohio. Improving our understanding of the relationships between factors that are associated with drug overdose deaths can enhance the quality of public policy and health care reach in Ohio.

Methods: Utilizing data from the Centers for Disease Control and Prevention (CDC) and University of Wisconsin Population Health Institute, this research seeks to quantify the associations between the drug overdose rate for counties in Ohio with various factors via statistical regressions.

Results: The overwhelming majority of drug/alcohol overdose deaths during the years 2017-2019 were unintentional. Drug overdose deaths and life expectancy are strongly associated. Communities with higher overdose rates have lower life expectancies. Socioeconomic status and health care factors, such as mental distress and physical inactivity, are significantly correlated with increased drug overdose deaths. Household income is significantly correlated with increased access to health care, implying that communities of lower socioeconomic status may lack adequate access to quality care and suffer from increased overdose deaths.

Conclusion: The data indicate the importance of access to health care and health care providers in response to drug overdoses in Ohio. Health care access is currently proportional to income; higher income households have a greater proportion of insured, as well as a greater number of primary care physicians. Thus, implementing policies that support health care infrastructure should be prioritized to increase the capacity of treatment in under-resourced (low-income and low socioeconomic status) communities.

Keywords: Regression; Drug overdose; Health care; Social determinants; Opioids

INTRODUCTION

The prevalence of drug overdose deaths has been devastating to Ohio public health. In 2017, the drug overdose deaths rate for Ohio was 46.3 compared to 21.7 for the national average.¹ This extraordinarily high difference makes it critical to further study the factors associated with drug overdose deaths in Ohio.

From 2017-2019, there have been 13 342 Ohioans who have died as a result of a drug overdose. This equates to an average of 4447 Ohioans per year over this timespan. The average number of Ohioans who died by a drug overdose was 3461 during 2014-2016 (the preceding 3-year period).² Thus, Ohio experienced an increase of nearly 1000 more deaths due to drug overdose over these time periods.

The number of drug overdose deaths has had an immense impact on public health. Authors of 1 study described the burden of opioid-related deaths, stating 1 in 65 deaths was opioid related in the United States.³ This represents an enormous toll in years of lost life. The years of lost life from just opioid-related deaths exceed those attributable to hypertension, HIV/AIDS, and pneumonia.³

Presently, the prevalence of drug overdoses has grown immensely. Since the start of the COVID-19 pandemic, every state, including Ohio, has experienced an increase in the number of overdose deaths.⁴ Specifically, more Ohioans died of an opioid overdose during a 3-month period in 2020 than at any time since the opioid epidemic began.⁵





Considering this increase in drug overdose deaths, Ohio currently only has the capacity to treat 20% to 40% of residents abusing or addicted to opioids.⁶ The need for treatment in combination with high costs of treatment, estimated at \$8.8 billion per year, demonstrates the amount of stress placed on the Ohio health care system by opioid addiction.⁶ This is exacerbated by the enduring nature of the issues; it was during October of 2017 that the US Department of Health and Human Services declared the opioid crisis a public health emergency.⁷ Thus, the necessity to research and find creative solutions to mitigate this epidemic is crucial.

Previous researchers have performed temporal analysis on opioid and drug overdose deaths in Ohio.⁸ Other studies have shown that opioid overdose death rates were associated with certain census tract level and socioeconomic characteristics in Ohio.⁹ However, there has yet to be research that expands upon the relationship between social determinants of health and the drug overdose rate. Social determinants of health are factors, including economic stability, health care access and quality, and living environment, that affect health and quality-of-life outcomes.

This report seeks to satisfy the need for increased research on the social determinants of health as it pertains to the drug overdose rate in Ohio. Therefore, this research aims to quantify the associations between the drug overdose rate for counties in Ohio with various health and health care factors. The hypothesis for this project was that underserved and under-resourced areas would have higher rates of drug overdose deaths. By better understanding the relationship between these factors, public policy and health care systems in Ohio can enhance the quality and reach of desperately needed care.

METHODS

Data

The data were compiled from the University of Wisconsin Population Health Institute's program County Health Rankings and Roadmaps, which obtained original data from various governmental and health institutions.¹⁰ Specific data sources are:

- The Comprehensive Housing Affordability Strategy (CHAS) is a subset of American Community Survey (ACS) data from the US Census Bureau sent to the US Department of Housing and Urban Development (HUD). These data depict the extent of housing problems and housing needs, particularly for low-income households.
- The Behavioral Risk Factor Surveillance System (BRFSS) is a collection of telephone surveys that collect state data about US residents regarding their health-related risk behaviors, chronic health conditions, and use of preventive services.
- National Center for Health Statistics (NCHS) is the nation's principal health statistics agency, providing data to identify and address health issues. The NCHS compiles statistical in-

formation collected from public and private health partners to help guide public health policy.

- National Vital Statistics System (NVSS) obtains information on deaths from the registration offices of each state. Federal law mandates the collection and publication of death registration statistics, which includes the cause of death when drug use is suspected.
- CDC WONDER (Wide-ranging ONline Data for Epidemiologic Research), a national database that collects public health information, was utilized to access the National Vital Statistics System (NVSS).¹¹ Data on drug overdose causes were analyzed via the dataset produced by CDC WONDER.

The desired variables were broken down by county across the entire United States. Thus, in order to prepare for analysis, the obtained variables and data were merged utilizing R-Studio, version 2022.12.0+353 (R Program for Statistical Computing) to create a singular dataset and trimmed to only include the 88 counties in Ohio.

Variables

Select variables that had statistics on the 88 counties in Ohio were chosen from the County Health Rankings and Roadmaps. The complete list of the variables and how they were defined are:

- Drug overdose rate. The number of deaths due to drug poisoning per 100 000 people. The drug overdose rate originated from the CDC and NCHS and were produced from the NVSS over the years 2017-2019.
- Life expectancy. The average number of years a person is expected to live. Life expectancy was calculated using data provided by NCHS and drawn from the NVSS over the years 2017-2019.
- Median household income. The 50th percentile for household income in a county. Household income was calculated from small area income and poverty estimates for the year 2019.
- Child poverty rate. The percentage of people under age 18 years who live in poverty. Child poverty rate was calculated from small area income and poverty estimates for 2019.
- Unemployment rate. The percentage of county population age 16 years and over who are not currently employed but seeking work. Unemployment rate was calculated from the Bureau of Labor Statistics for 2019.
- Severe housing problems. The percentage of households with at least 1 of 4 housing problems: overcrowding, high housing costs, lack of kitchen facilities, or lack of plumbing facilities. Severe housing problems was calculated using CHAS data from 2017.
- Mental distress frequency. The percentage of adults reporting 14 or more days of poor mental health per month. Frequent



Mental distress was calculated from BRFSS, which is a random telephone survey from the year 2018.

- Physical inactivity. The percentage of adults age 20 years and over who report having no leisure-time physical activity. Physical inactivity was calculated by the United States Diabetes Surveillance System for the year 2017.
- Primary care physician ratio. The ratio of primary care providers per 100 000 people. The number of primary care providers was provided by the American Medical Association (AMA). The AMA maintains the AMA Physician Masterfile which contains information on doctors of medicine and doctors of osteopathic medicine for the year 2018.
- Percentage of uninsured. The percentage of population under age 65 years without health insurance. Percentage of uninsured was calculated from small area health insurance estimates for the year 2018.
- Preventable hospitalizations. The rate of hospital stays for ambulatory-care sensitive conditions per 100 000 Medicare enrollees. Preventable hospitalizations was calculated from the Mapping Medicare Disparities tool for the year 2018.
- Percent rural. The percentage of population that live in a rural area. Percent rural was calculated using Census population estimates from 2010.

Statistical Analysis

The CDC WONDER dataset was used to illustrate the proportion of drug poisonings for each respective cause of death. This comparison, shown in Figure 1, denoted the drug/alcohol induced cause and the percentage of total deaths associated with each cause. The possible causes of death were unintentional, undetermined, suicide, homicide, and all others.

The local medical examiner or coroner established the cause and manner of death, as these deaths generally fall under their jurisdiction. The cause of death was determined in accordance with NVSS guidance and submitted by completing the death certificate.¹² Specifically, the NVSS and National Association of Medical Examiners state that the best classification for manner of death in deaths due to the misuse or abuse of drugs/alcohol without any apparent intent of self-harm is ‘accident.’

An initial linear regression was conducted in order to establish purpose and analyze the relationship between drug overdose rate and life expectancy for Ohio counties. The linear regression was performed via the Pearson correlation test. This relationship is depicted in Figure 2.

For all tests performed in this study, a Bonferroni adjusted significance level was set at $\alpha = 0.01$ in order to take into account the number of variables being tested, as increasing the number of variables may incorrectly trigger a significant test result.

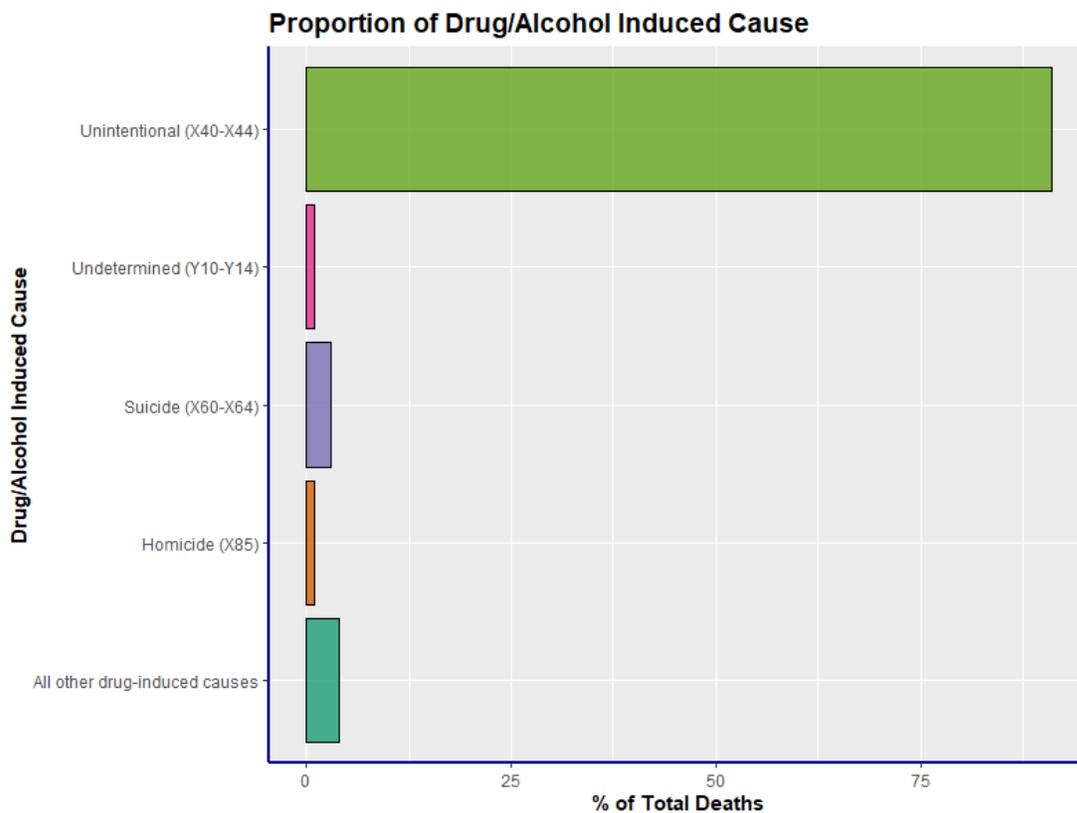


Figure 1. Proportion of Deaths Attributed to Drug/Alcohol Induced Cause for Residents in Ohio

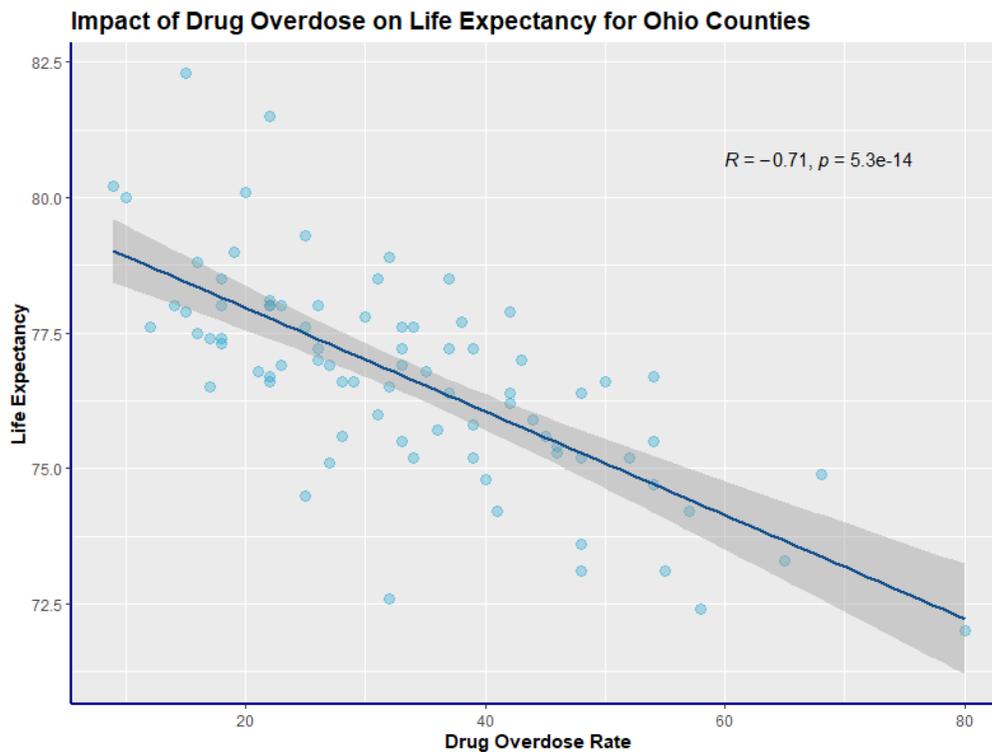


Figure 2. Relationship Between Life Expectancy and Drug Overdose Rate for Ohio Counties

A Pearson correlation test was performed between drug overdose rate and each of the following predictors: median household income, child poverty rate, unemployment rate, severe housing problems, mental distress frequency, and physical inactivity (Table 1). The median household income was transformed utilizing the log to properly scale the data. The correlation coefficient and corresponding P value from the Pearson correlation test was used to analyze the relationship between drug overdose rate and the examined variables.

A more in-depth analysis was conducted to determine the relationship between different health care factors (percentage of uninsured, primary care physician ratio, and preventable hospitalizations) and the log transformation of median household income for Ohio counties utilizing Pearson correlation tests (Figure 3).

A Pearson correlation test was performed between percent rural and the log transformation of median household income (Figure 4).

RESULTS

The percentage of total deaths associated with each drug/alcohol induced cause was plotted on a bar chart [Figure 1]. The vast majority of overdose deaths in Ohio from 2017-2019 are attributed to unintentional drug/alcohol overdoses (91%).

The Pearson correlation test for drug overdose rate and life expectancy was plotted [Figure 2]. The correlation test for life expectancy demonstrates a significant negative relationship ($P = 5.3e-14$, $\alpha = 0.01$).

The Pearson correlation tests between drug overdose rate and median household income, child poverty rate, unemployment rate, severe housing problems, mental distress frequency, and physical inactivity were conducted; results are shown in Table 1. The relationships between drug overdose rate and each of the health-related and socioeconomic factors were significant ($\alpha = 0.01$). There was a significant negative relationship between drug overdose rate and median household income. There was a significant positive relationship between drug overdose rate and child poverty rate, unemployment rate, severe housing problems, mental distress frequency, and physical inactivity.

The Pearson correlation test for the log transformation of median household income and percentage of uninsured, primary care physician ratio, and preventable hospitalizations were also plotted and are shown in Figure 3. The plots demonstrate a significant negative relationship between median household income and the variables: percentage of uninsured ($R = -0.65$, $P = 1e-11$, $\alpha = 0.01$) and preventable hospitalizations ($R = -0.4$, $P = 0.00012$, $\alpha = 0.01$). There is also a significant positive relationship between median household income and primary care physician ratio ($R = 0.34$, $P = 0.0013$, $\alpha = 0.01$).

The Pearson correlation test for log transformed median household income and percent rural was plotted and is shown in Figure 4. The plot depicts a significant negative relationship between median household income and percent rural ($R = -0.29$, $P = 0.0057$, $\alpha = 0.01$).



Table 1. Relationship Between Social Determinants of Health and Drug Overdose Death Rate for Ohio Counties

Pearson Correlation Coefficient with the Variable: 'Drug Overdose Rate'						
	Median household income	Child poverty rate	Unemployment rate	Severe housing problems (%)	Mental distress frequency	Physical inactivity
Drug overdose rate	-0.39	0.57	0.39	0.38	0.32	0.34
Significance level	<i>P</i> value < 0.001	<i>P</i> value < 0.001	<i>P</i> value < 0.001	<i>P</i> value < 0.001	<i>P</i> value < 0.01	<i>P</i> value < 0.01

Median household income underwent log transformation to satisfy normality condition.

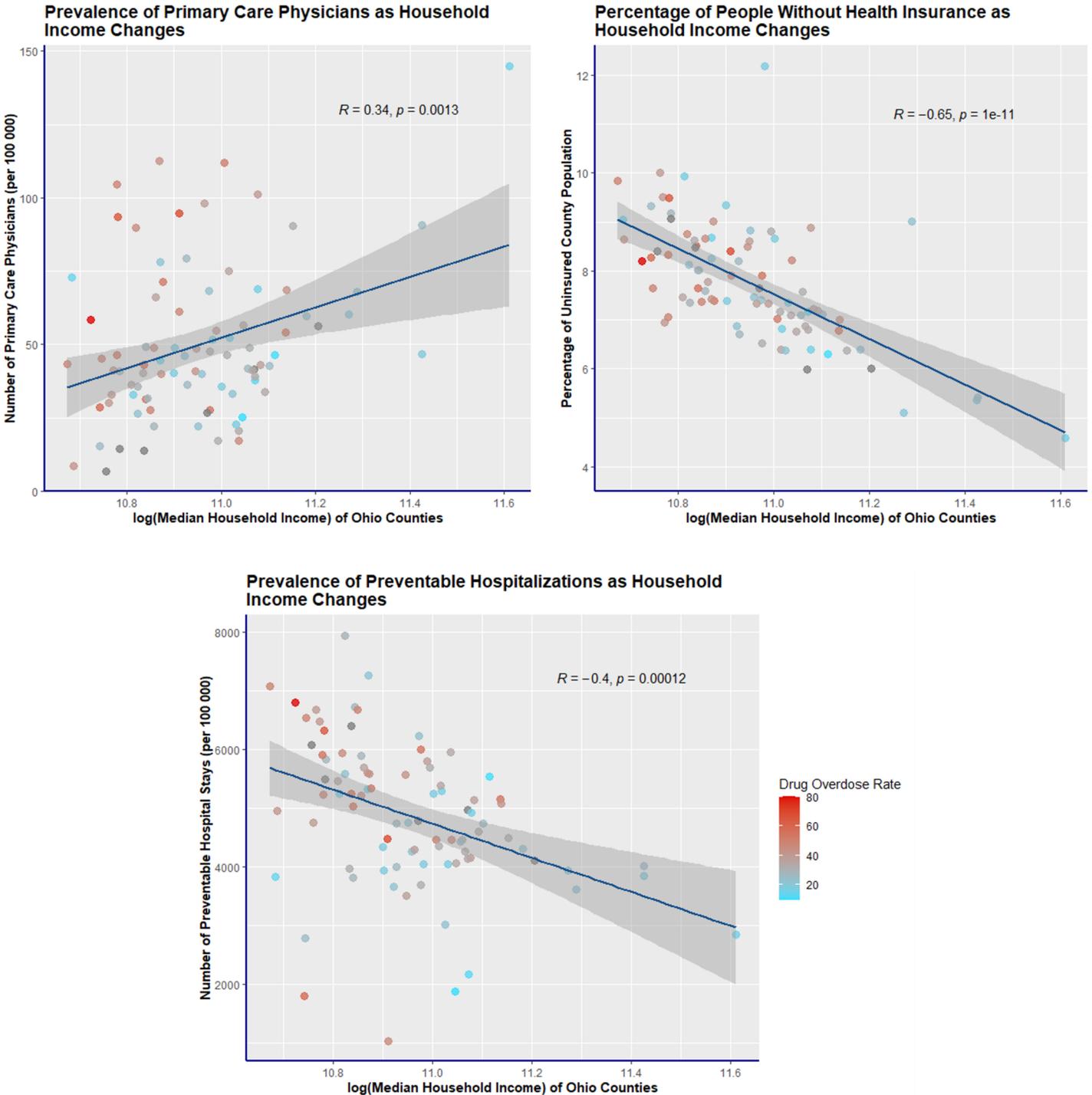


Figure 3. Relationship Between Health Care Factors and Log Transformation of Median Household Income for Ohio Counties



Impact of Rural Population Density on Household Income

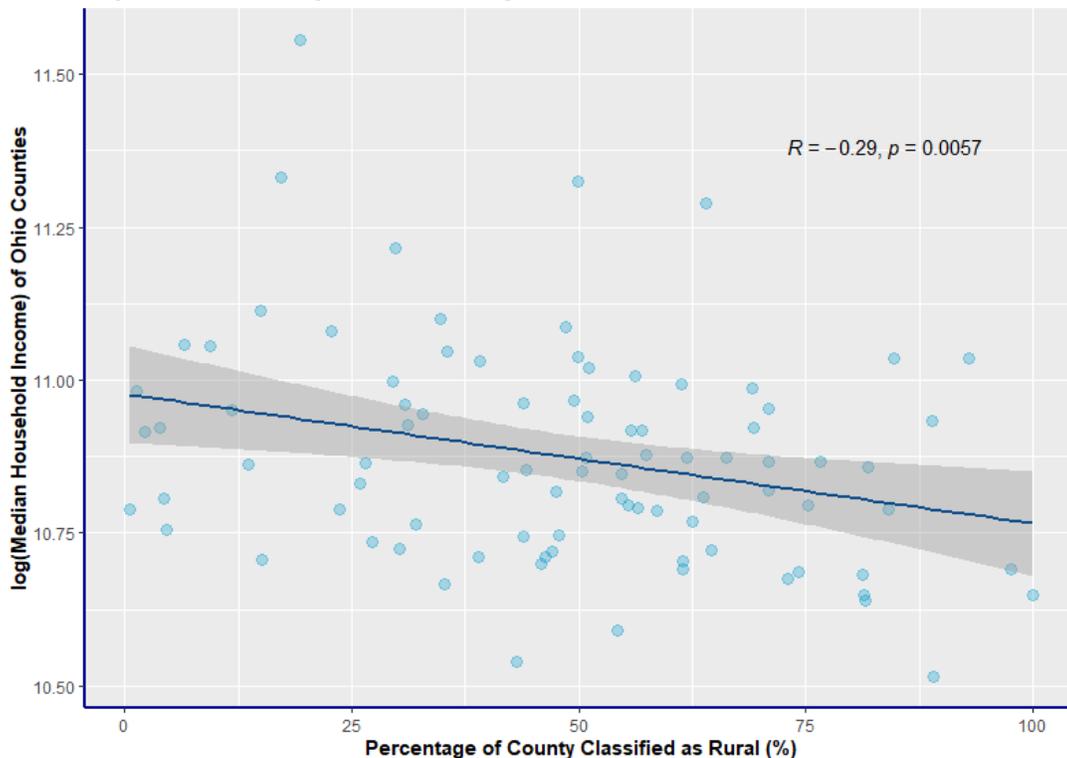


Figure 4. Relationship Between Percent Rural and Log Transformation of Median Household Income for Ohio Counties

DISCUSSION

This project sought to quantify relationships between social determinants of health and the drug overdose death rate in Ohio, with particular focus on health care as a social determinate of health. In Figure 1, it is evident that the preponderance of drug overdose deaths are attributed to unintentional causes.

Overdose deaths have a destructive effect on communities. Drug overdose deaths result in an average of 3.2 years of lost life for people in Ohio. As shown in Figure 2, the overall life expectancy for counties in Ohio is strongly correlated to the drug overdose rate. Each unit increase in the drug overdose rate (ie, an increase from a drug overdose rate of 40 to 41) is associated with -0.09564 years in life expectancy. Hence, an Ohio county with a drug overdose rate of 10 is associated with a population life expectancy of approximately 1 year lower than a county with a drug overdose rate of 0. Delaware County, for example, had the highest life expectancy rate of 82.3 years and had a drug overdose rate of 15. On the other hand, Scioto County had the lowest life expectancy of 72 years and a drug overdose rate of 80, which is 8 years of lost life associated with overdose deaths. This illustrates the profound impact of drug overdose deaths in Ohio and suggests the urgency and necessity of identifying strategies to minimize the number of accidental overdose deaths.

The hypothesis tested in this research was that underserved and under-resourced areas, indicated by selected social determinants

of health, would have higher rates of drug overdose deaths. Various socioeconomic and health care factors (median household income, child poverty rate, unemployment rate, severe housing problems, mental distress frequency, and physical inactivity) supported the hypothesis and had statistically significant relationships with the drug overdose death rate, as shown in Table 1.

These data illustrate a clear relationship between increased mental distress and higher rates of overdose deaths. This also speaks to the complex relationships among social determinants of health and mental health including substance use; exposure to adverse social determinants of health factors can elevate the level of stress experienced by individuals which can then increase their risk of substance use problems.¹³

Similarly, these data highlight the important relationship between the drug overdose death rate and socioeconomic status. Lower socioeconomic status, lower median household incomes and higher rates of child poverty, unemployment, and severe housing problems, was strongly correlated with higher rates of drug overdose deaths. This aligns with previous research using Census data that found socioeconomic status correlated with opioid overdoses.⁹

Thus, equitable access to quality and consistent health care could be another factor that corresponds with decreased rates of overdose deaths in Ohio. Figure 3 shows that household income is significantly correlated with access to health care. Lower socioeconomic status is associated with higher proportions of uninsured



population and lower ratios of primary care physicians. Lower socioeconomic status is also associated with higher rates of preventable hospital stays. For example, the average median household income is \$58 037.75 for Ohio counties. Delaware County has a median household income of \$110 252 and Scioto County has a median household income of \$45 410. Delaware County consistently places in the top quartile for factors indicating access to quality health care. However, Scioto County places in the bottom quartile for these same factors. Hence, the disparities in household income imply that communities of lower socioeconomic status may lack adequate access to quality care and suffer from increased drug overdose deaths.

Enhancing the coverage and quality of health care may help mitigate these inequities and ultimately help stop the overdose epidemic. As depicted in Figure 4, a higher rural population density is correlated to lower median household income for Ohio counties. Therefore, these data emphasize the need to implement policies that direct aid and support to under-resourced communities, especially in rural and low-income areas.

One limitation of this analysis was that the selected variables were compiled from existing data. Further research studies that better select variables, including newly developed variables which focus on individuals' identified barriers to health and wellness, can enhance understanding on this topic. One potential way to identify these factors is by interviewing patients to determine what factors they perceive to be the greatest barriers to receiving quality health care.

PUBLIC HEALTH IMPLICATIONS

These results suggest the value of both specific strategies to focus on drug overdose rates and behaviors and broader strategies to address some of the contextual circumstances which exacerbate opioid use. These data established that areas that have lower socioeconomic status are more susceptible to higher rates of drug overdose deaths. Furthermore, it is known that minority and lower socioeconomic communities face many barriers that inhibit them from receiving consistent and quality health care.¹⁴ Increasing funding to mobile care units and preexisting organizations such as Project DAWN,¹⁵ which is an organization that distributes naloxone and provides training to prevent opioid overdose, could help remove some barriers to receiving lifesaving care and resources.

One proposed solution to specifically target the drug overdose rate is to implement supervised injection services. Studies have shown that supervised injection services promote safer injection conditions, enhance access to primary health care, and reducing the overdose frequency.¹⁶ Moreover, the data do not suggest that supervised injection services increase drug injecting, drug trafficking, or crime in the surrounding community.⁸ Hence, supervised injection services may provide a safe environment in which people

most susceptible to drug overdoses can receive the help and care they need and deserve.

From a broader view, the data exemplify the importance of access to quality health care professionals in response to the drug overdose epidemic for the entire state of Ohio. Thus, enhancing services in these areas by hiring and allocating more health care professionals and resources could help in this fight against the drug overdose epidemic. Having incentive programs for physicians to practice in rural areas, such as loan forgiveness programs, may increase accessibility of care and help decrease the drug overdose rate.

The correlation between mental distress and overdose rates should urge policymakers to advocate for increased support systems, such as crisis help lines, and quality mental health providers. In conclusion, having a targeted response to lower socioeconomic and rural communities in Ohio should be a top priority for policymakers and public health officials.

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