The Impact of Risky Behaviors on Death Rates

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Abstract:

This paper examines the connection between risky behaviors and two different measurements of deaths: premature deaths and drug-overdose deaths. This study analyzes if the premature age-adjusted death and drug-overdose death rate are associated with risky behaviors. This study looks at every county within the United States, with the sample from the County Health Rankings 2021 Edition. It is shown that at the county level, a higher number of premature deaths and drug-overdose deaths occur when the risky behaviors such as smoking, opioid dispensing are present, however a lesser number of deaths occur when the behaviors of excessive drinking and adult obesity are present, with chlamydia rate increasing premature deaths yet decreasing drug-overdose deaths.

Introduction:

Deaths related to drug usage have been rapidly increasing over the last decade, especially within the United States. A report conducted by the Washington Post illustrated how the number of drug deaths in the United States stands out greatly compared to other wealthy countries. The 2019 report looked at drug caused deaths for people between the ages of 15 to 64 for countries in the European Union, Norway, Turkey, and the United States. The United States by far had the highest number of deaths, accounting for over 21 drug-caused deaths per 100,000 population in comparison to Norway, the second leading country for drug related deaths, with only 5 drug-caused deaths per 100,000 population (Keating and Bernstein, 2021).

This paper examines the connection between risky behaviors and two different measurements of deaths: premature deaths and drug-overdose deaths. Risky behaviors in this study are represented by substance usage, drug dispensing rates, adult health, and sexually transmitted infections, specifically smoking, excessive drinking, an opioid dispensing rate, adult obesity, and the chlamydia rate. This paper was motivated by previous work done by Blake-Gonzalez et al. (2020); however, it adds more variety of risky behaviors, but uses a similar research approach and control variables. The question that this paper examines is: do risky behaviors affect the premature age-adjusted death rate and the drug-overdose death rate? It is hypothesized that at the county level, an increase in risky behaviors will increase the premature age-adjusted death rate and the drug-overdose death rate, controlling for several economic, demographic and region variables. Findings conclude that the premature age-adjusted death is an increasing function of the percentage of smokers, the opioid dispensing rate, and the chlamydia rate but a decreasing function of the percentage of excessive drinking within a county. The drug-overdose death rate is an increasing function of the percentage of smokers and the opioid dispensing rate but a decreasing function of the percentage of excessive drinking, the percentage of adult obesity and the chlamydia rate within a county.

Literature Review

I. *Mortality within the United States*

The Center for Disease Control (CDC) (2021) reported that more than 2,850,000 million Americans died in the year 2019, accounting for around 870 deaths per 100,000 population. Heart disease, cancer, and accidents, all classified as unintentional injuries, are the top three causes of death in the United States (CDC, 2021a). Looking into the causes of or reasoning behind mortality rates, whether it be from the viewpoint of a county, state, country or globally, can be difficult to comprehend due to the complexity of the situation at hand. Many studies have examined influential factors that contribute to different morality rates, however other research is needed to consider all possibilities about what influences different measurements of mortality.

In trying to find answers regarding what contributes to mortality rates, this literature review will be divided into four sections, all of which can describe influences on mortality rates: economic factors, demographic factors, health factors and risky behaviors.

II. *Economic factors that contribute to mortality rates*

'Economic misery,' or 'deaths of despair,' are terms used to often to describe how economic situations can affect the death of an individual. As specified by Blake-Gonzalez et al. (2020), the idea of 'deaths of despair' occur within individuals who are perceived to have died from overdoses occur when they believe that their economic possibilities to be unpromising. This can be due to a variety of economic factors such as unemployment and household income. The study from Blake-Gonzalez et al. (2020), looked at that the drug-overdose death rate within each jurisdiction. The drug-overdose death rate within their framework is measured as the logarithm of the number of people who die from drug-related deaths per 100,000 population, age-adjusted.

Age-adjusted, as stated by Blake-Gonzalez et al. (2020), accounts for varying age distributions of populations in jurisdictions that could drive differences in behaviors, and it is expected that pre-teens and very mature adults would not have high levels of drug abuse. They predict that the drug-overdose death rate would be an increasing function of the unemployment rate and a decreasing function of median household income. Results showed that a $10,000 increase in median household income was associated with an increase of the drug-overdose death rate by around 1.4% and that a 2% absolute increase in the median household income was associated with a decrease of more than 6.4% in the drug-overdose death rate (Blake-Gonzalez et al., 2020). These results are not surprising because both unemployment and household income can cause distress which can in turn lead to drug-usage and thus resulting in elevated rates of drug-overdose deaths. Similarly, research done by Nosrati et al. (2019) showed how mortality rates were associated with economic hardships, especially with low economic incomes being associated with a higher number of deaths due to drugs.

Another interesting finding by Hollingsworth et al. (2017), is that within a county, as the unemployment rate increases, the opioid death rate per 100,000 increases. This is important because during times of economic weakness, such as an increase in a county's unemployment rate, the mortality rate can also tend to increase. Similarly, Ruhm (2018a) found that counties who were experiencing respective economic decline had higher than average rates of deadly overdoses.

An interesting yet unexpected relationship found by Blake-Gonzalez et al. (2020) looked at longer commute times to work. They predicted that longer commutes to work increase the drug-overdose mortality rate. Their results indicate that a five-minute increase in commuting time to work was associated with over a 21% increase in a county's drug-overdose death rate.

This result, according to Blake-Gonzalez et al. (2020), represents the disutility that individuals have towards longer commute times, which could lead to drug abuse and fatal overdoses. Longer commute times from the residence to the workplace may impose, according to Blake-Gonzalez et al. (2020) greater financial, emotional, and temporal costs on the individual which in turn, could discourage labor force participation, thus reducing the rate of employment. Blake-Gonzalez et al. (2020) use commuting time to work as a demographic variable due to their sample solely being counties and cities within Virginia, however this measurement would be a useful demographic or economic measure for a larger sample size, such as every United States county because as stated by Blake-Gonzalez et al. (2020), longer commutes to work could discourage labor force participation and thus decrease the rate of employment, which could contribute to increasing mortality rates.

III. *Demographic factors that contribute to mortality rates*

It can be easy to categorize a particular group of people based on demographics, such as location, educational level, race, gender, and so forth. Demographics can specifically focus on certain characteristics of a group, which is important when describing a society, particularly mortality rates.

Recent studies have looked at how location can influence mortality rates. It is noted by Blake-Gonzalez et al. (2020) that opioid usage is primarily an occurrence in rural areas; thus, using population density as a measurement for ruralness, they predicted that the drug-overdose death rate is a decreasing function of population density. Results given by Blake-Gonzalez et al. (2020) indicate that more rural areas have higher levels of drug-overdose mortality, which in turn, reflects the lack of economic opportunities that can exist in these rural areas.

Regional differences also affect mortality rates. Case and Deaton (2015) discuss temporal and spatial joint evolution of poisoning and suicide mortality and find that mortality rates were higher in the South and West compared to mortality rates in the Midwest and Northeast.

Education is a wide-ranging demographic that can measure the amount of instruction an individual or group of people have previously obtained. Educational measurements are helpful in separating different groups of people based on their academic achievement. Many articles have looked at the relationship between education and the impact on mortality rates. Cutler et al. (2011) discuss how mortality rates are lower in those with more educational attainment. An important result from the study concludes that while mortality rates have decreased, the sizable reductions are for men and those who are college educated (Cutler et al., 2011).

Yet, differing results from Case and Deaton (2015) specifically focus on different levels of education for white non-Hispanics. Their results explain that while all individuals within all the educational groups studied experience increases in mortality, individuals with less education had the biggest increase in mortality (Case & Deaton, 2015). Blake-Gonzalez et al. (2020) measured educational attainment by the percent of the population aged 25 years and older with a high school diploma and found that it was not statistically significant in determining drug-overdose deaths.

An interesting yet often overlooked demographic that some studies have examined is jailing or incarceration rates and if they influence mortality rates. Nosrati et al. (2019) closely studied the relationship between incarceration rates and age-standardized mortality from drug-use disorders, respectively drug-related deaths. Their results indicate that an increase in the jail and incarceration rate is associated with an increase in the drug-related mortality per county (Nosrati et al., 2019). These results are important in describing the relationship within their specific study, such that increases in the jailing and incarceration rate are associated with increases in the county level mortality rates from drug disorders. With similar measurements, Blake-Gonzalez et al. (2020), motivated from the work done by Nosrati et al. (2019), used the jailing rate to predict that the drug-overdose death rate would be an increasing function of the county jailing rate. Their results showed that a five percent absolute increase in the jail population increased the drug-overdose death rate by over 7% (Blake-Gonzalez et al., 2020). The results from Blake-Gonzalez et al. (2020) are consistent and very similar with the results from the study done by Nosrati et al. (2019).

Many recent studies have looked at different races and the roles they play, if any, in impacting mortality rates. Chan et al. (2014) studies the relationship between community characteristics and mortality rates and studies sociodemographic characteristics such as race. An important finding from the study was that counties with higher amounts of Asians or Hispanic residents tended to have lower all-cause mortality rates while counties who had higher amounts of Black or White residents had higher all-cause mortality rates (Chan et al., 2014). Specifically addressing the direct effect of race on mortality rates, Case and Deaton (2015) examined mortality over a 15-year period among white non-Hispanic Americans and found that there was an increase in white non-Hispanic mortality while the all-cause mortality of both Hispanics and Blacks decreased. These results found are due to, as mentioned by Case and Deaton (2015) an increasing death rate from external causes, mainly from increases in alcohol and drug poisonings and suicide. Also found by Case and Deaton (2015) is that the ratio of black non-Hispanics to white non-Hispanics mortality rates for the age group of 45-54 had decreased, mainly because of the increase in white mortality, which can be due to increases in suicide, as well as drug and alcohol poisonings (Case & Deaton, 2015). Blake-Gonzalez et al. (2020) also used a variable to measure the percentage of the population that was Caucasian, however their results indicated that it was not statistically significant in determining drug-overdose deaths.

IV. *Health behaviors that contribute to mortality rates*

Some studies have examined medical condition impacts on mortality rates. Case and Deaton (2015) present information about mortality by causes for white non-Hispanics ages 45-54. They looked at a variety of health conditions such as lung cancer, chronic liver diseases and diabetes, which were measured as deaths per 100,000. During the period of 2000 to 2015 it was noted that lung cancer deaths decreased, while chronic liver disease deaths increased, and diabetes deaths stayed constant. Noted by Case and Deaton (2015), the obesity epidemic has made diabetes a concern for Americans, yet, diabetes deaths, have not been a major increasing threat. This is because other factors such as poisoning either from drugs or alcohol grew and become more apparent compared to diabetes and lung cancer (Case and Deaton, 2015).

While the previous medical conditions discussed contribute to death rates, other factors such as disability rates can contribute as well. Blake-Gonzalez et. al (2020), look at disability for measuring death rates because oftentimes, disability status is accompanied by pain or discomfort and debilitating side effects, which can stimulate an increase for the demand of drugs usage and abuse. While they predicted that the greater the percentage of a population receiving disability payments, the greater the drug-overdose death rate, they found that the disability rate was not statistically significant in describing drug-overdose deaths (Blake-Gonzalez et. al, 2020).

Health related issues, as studied by many researchers, such as medical conditions, prescription rates, alcohol and tobacco consumption and drug usage are important components in influencing mortality rates.

V. *Risky behaviors that contribute to mortality rates*

While there is a variety of literature dedicated to finding numerous economic and demographic variables impacting mortality rates, other literature also looks at how individual risky behaviors such as smoking, drinking, drug usage, prescription rates and medical conditions impact mortality rates.

Drugs are a major determining component in mortality rates because of how deadly these substances can be. The United States has had an increase in overdose death rates which in part are from sedatives, cocaine, and stimulants/methamphetamine (Segel & Winkelman, 2020). Some recent studies have looked at the association between different types of drug substances and their influence on mortality rates. Research done by Segel, and Winkelman (2020) looked at the relationship between state-level opioid overdose death rates from the years 1999 to 2004 and the overdose death rates for opioids and other drug substances. Their results indicate that all states had increases in the rate of deaths from opioids and other substances, but states that had higher opioid overdose death rates during the years of 1999-2004 had much greater increases in the opioid overdose death rate compared to states that had lower opioid overdose death rates during 1999-2004 (Segel & Winkelman, 2020). It is significant to see the shift in the type of drugs that contribute to mortality rates. For example, Ruhm (2018a) mentions how at the beginning of the 21st century, the increase in drug mortality was mostly due to increases in opioid analgesic mortality, however, more recently, the increases have been from fentanyl and heroin. Also, increases in drug mortality have also been accredited to the large growth in the usage of OxyContin and other prescription opioids (Ruhm, 2018b).

Tobacco and alcohol consumption are two health factors that can widely contribute to an increase in mortality rates. Case and Deaton (2015) state that the change in all-cause mortality, focusing on white non-Hispanics, was largely due to the rising death rate from exogenous factors, such as alcohol poisonings. They also make the point that death rates from alcohol poisonings for white non-Hispanics in 2013 exceeded the death rate from alcohol poisonings for black non-Hispanics, even though in the year 1999 the roles were reversed (Case & Deaton, 2015). This result is important when comparing how health and behavioral factors contribute to mortality rates among different races.

Focusing more on the relationship between smoking or tobacco use and rising educational mortality, Cutler et al. (2011) find that differential decreases in tobacco usage influence the increasing educational gaps in mortality. Cutler et al. (2011) also use an example of how smoking increased for non-college educated women but decreased by a large amount for women college attendees (Cutler et al., 2011). Once again, this example is important when examining the relationship between tobacco usage or smoking and mortality rates as well as other education, gender, and other demographics.

The prescription rate is useful in determining the number of legally available drugs available to the specific area, which in turn, can contribute to the number of drugs being used and abused. Blake-Gonzalez et. al (2020) examine the average opioid prescribing rate within each county and predict that the higher the prescribing rate, the greater the drug-overdose death rate because of the theory that the more drugs available within a community, the greater the potential drug-overdoses and thus, death. They found that the prescribing rate was positively correlated with the death rate. In fact, five additional prescriptions annually above the median in a jurisdiction’s prescription rate is associated with an increase of about 1% in the death rate (Blake-Gonzalez et. al., 2020). An important contributor to an increase in overdose deaths are pharmaceutical companies in increasing accessibility of opioids (Nostrati et at., 2019). Nostrati et. al (2019) found that opioid prescription rates were associated with higher rates of mortality due to drug use disorders. Additionally, during the 1990s, there was an increase in the availability of opioid prescriptions that coincided with associated mortality (Case and Deaton, 2015).

Data and Methodology

By examining county level data across the entirety of the United States, I will analyze the relationship between risky behaviors and two measurements of death: the premature age-adjusted death rate and the drug-overdose death rate. The research question that the study will follow is: Do risky behaviors affect the premature age-adjusted death rate and the drug-overdose death rate? In this study, risky behaviors will be represented by alcohol and tobacco usage, a measure of the opioid dispensing rate, a measurement of adult obesity and a chlamydia rate. I hypothesize that, at the county level, the increase in risky behaviors will increase the premature age-adjusted death rate and the drug-overdose death rate, controlling for several economic, demographic, health, and region variables.

The sample was collected from 2021 County Health Ranking. County Health Rankings collects data for every county within the United States, except the State of Virginia, which the data includes both counties and major cities. In total, there are 3,143 counties and major cities within my dataset, all of which is taken from 2021 County Health Rankings. I used the 2021 edition from County Health Rankings, the variables used within their framework are measured from different years, which will be mentioned when discussing each individual variable. The years covered from the 2021 County Health Rankings edition range from the years 2010 until 2019. While discussing each variable, I will specify the specific years for which the variable was measured.

To test the hypothesis, there will be two ordinary least squares (OLS) regressions used because of the two different measures of mortality. The first regression will use the premature age-adjusted death rate as the dependent variable. The premature age-adjusted death rate is from County Health Rankings and is measured as the three-year average for the years 2017 to 2019. While the dependent variables range from a span of multiple years, each variable only has one observation. It is measured as the number of deaths under age 75 per 100,000 population. Anytime the term ‘age-adjusted’ is mentioned only the population age 75 and under is being used. Age-adjustment is used because it allows for the comparison of the data across counties when the population of people under the age of 75 differs. The second regression uses the drug-overdose death rate as the dependent variable. The drug-overdose death rate is measured as the number of drug-poisoning deaths per 100,000 population and is from County Health Rankings and is measured as the three-year average for the years of 2017 until 2019.

There are several independent variables of interest within this study, specifically focusing on risky behaviors. The first main variable of interest is the percentage of adults who are current smokers, age adjusted. In the context of the percentage of smokers, age-adjusted just focuses on the number of smokers within a county under the age of 75 per 100,000 population. This data on percent smokers was collected from County Health Rankings and was measured in the year 2018. The data for the variable is taken from individuals self-reporting if they are smokers to telephone surveys. I predict that a higher percentage of smokers will be associated with a higher premature age-adjusted death rate and drug-overdose death rate. Another main variable of interest that relates to substance usage is the percentage of adults reporting binge or heavy drinking (age-adjusted). In this context, age-adjusted just focuses on the number of people who report heavy or binge drinking under the age of 75 per 100,000 population. The data on percent excessive drinking is from County Health Rankings and is measured from the year of 2018. The data for the variable is taken from individuals self-reporting their alcohol consumption to telephone surveys. The predicted relationship that a higher percentage of excessive drinking will be associated with a higher premature age-adjusted death rate and drug-overdose death rate. The last main variable of interest which encapsulates substance usage is measured as the retail opioid prescriptions dispensed per 100 persons and is taken from the CDC from the year of 2020. The predicted relationship is that a higher opioid dispensing rate will be associated with a higher premature age-adjusted death rate and drug-overdose death rate.

Another main variable of interest is the percentage of obese adults aged 20 and over who report a body mass index (BMI) greater than or equal to 30 kg/m^2. This data is from County Health Rankings and is taken from the year of 2017. The predicted relationship is that a higher percentage of obesity will be associated with a higher premature age-adjusted death rate and drug-overdose death rate. The last variable of interest measures the number of newly diagnosed chlamydia cases per 100,000 population. This data is taken from County Health Rankings from the year 2018. The data reported for the Chlamydia rate is measured from case notification data provided from the CDC as well as data from collected from programs or projects that monitor STDS. The predicted relationship of the chlamydia rate is a positive association, indicating that a higher chlamydia rate will be associated with a higher premature age-adjusted death rate and drug-overdose death rate.

An additional health variable is measured as the percentage of adults reporting fair or poor health (age-adjusted), which is taken from County Health Rankings from the year 2018. I predict a positive association between the percentage of fair or poor health and the dependent variables, indicating that the higher the percentage of fair or poor health will be associated with a higher premature age-adjusted death rate and drug-overdose death rate.

Control variables are important because they can also influence the outcomes of the dependent variables. This study will focus on economic, demographic, health and region control variables. The first economic control variable is median household income, which is measured by the income where half of the households in a county earn more, and half earn less. This data was taken from County Health Rankings and is measured from the year of 2019. The predicted relationship is that a higher median household income will be associated with a lower premature age-adjusted death rate and drug-overdose death rate. Another economic control variable is the violent crime rate, which is measured as the number of violent crime offenses per 100,000 population and is from County Health Rankings. The data was measured as the average during the years of 2014 and 2016 since there was not 2015 data published. The predicted relationship is that a higher violent crime rate will be associated with a higher premature age-adjusted death rate and drug-overdose death rate.

The unemployment rate is measured as the percentage of the population ages 16 and older who are unemployed but seeking work. The data for the unemployment rate is from County Health Rankings, measured from the year 2019. I predict a positive association between the unemployment rate and both dependent variables, indicating that a higher unemployment rate will be associated with a higher premature age-adjusted death rate and drug-overdose death rate. Blake-Gonzalez et al. (2020) stated that higher levels of unemployment can cause emotional stress which could potentially elevate drug-usage and lead to more premature deaths and drug-overdose deaths within a county.

An interesting variable that was used in the study done by Blake-Gonzalez et al. (2020) focused on commuting time to work and their results indicated a strong positive association with the logarithm of the age-adjusted drug-overdose death rate. I am including a variable that represents the percentage of people who have a long commute to work and drive alone, which is like the variable that Blake-Gonzalez et al. (2020) but instead of focusing on counties within one state, this study focuses on all counties in the country. The percentage of long commuters driving alone is measured as the percentage of the workforce driving alone to work who have a commute that is longer than 30 minutes. This variable was obtained from County Health Rankings and was measured by the 5-year average from the years 2015-2019. I predict a positive association between the percentage of long commutes driving alone and the dependent variables, meaning that a higher percentage of long commute driving alone will be associated with a higher premature age-adjusted death rate and drug-overdose death rate.

The education variables used in this study are from the United States Census Bureau, specifically from the ACS 5-year estimates (table S1501) from the year 2017. There are seven different measurements for the education variables ranging from no high school education to a graduate or professional degree. The omitted educational variable is the percentage of the population age 25 and older who have less than a high school education. The first educational variable is the percentage of the population ages 25+ who are high school graduates. The predicted relationship is a that a higher percentage of the population who are high school graduates will be associated with a lower premature age-adjusted death rate and drug-overdose death rate, relative to the population with less than a high school education. Another educational variable is the percentage of the population ages 25+ who have some college education, but no bachelor’s degree. The predicted relationship is a higher percentage of the population with some college education, but no bachelor's degree will be associated with a lower premature age-adjusted death rate and drug-overdose death rate, relative to the population with less than a high school education. The next educational variable that will be used in the study is the percentage of the population ages 25+ who have a bachelor's degree or a higher degree. I predict that a higher percentage of the population who have a bachelor's degree or higher degree will be associated with a lower premature age-adjusted death rate and drug-overdose death rate, relative to the population with less than a high school education.

An important demographic variable that was measured in a study done by Blake-Gonzalez et al. (2020) focused on incarceration rates, so I included a variable that measured jail population collected from the Vera Institute of Justice during the year 2018. The jail population is measured as the number residents aged 15 to 64 in a county jail per 100,000 population. Blake-Gonzalez et al. (2020) also used county level incarceration rates from Vera Institutes of Justice within their study and found a positive association within their study between incarceration rates and mortality rates, which is why I predict that a higher jail population will be associated with a higher premature age-adjusted death rate and drug-overdose death rate. This variable is an important indicator of mortality rates, because as stated previously by Blake-Gonzalez et al. (2020), incarceration has a disruptive impact on communities and families, which could increase the number premature deaths and drug-overdose deaths within a community.

Race is an important demographic measurement when studying mortality rates. Four race variables will be measured in this study: percent non-Hispanic black, percent non-Hispanic white, percent Hispanic and percent Asian. All four variables are from County Health Rankings from the year 2019. The percentage of non-Hispanic White is measured as the percentage of the population that is non-Hispanic white. The percentage of non-Hispanic White is the dropped group. The percentage non-Hispanic Black is measured as the percentage of the population that is non-Hispanic Black or African American. I predict that a higher percentage of non-Hispanic Black will be associated with a higher premature age-adjusted death rate and drug-overdose death rate, relative non-Hispanic White. The percentage of Hispanic is measured as the percentage of the population who is Hispanic. I predict that a higher percentage of Hispanic will be associated with a lower premature age-adjusted death rate and drug-overdose death rate relative to non-Hispanic white. Another race variable is measured as the percentage of the population that is Asian. I predict that a higher percentage of Asian will be associated with a lower premature age-adjusted death rate and drug-overdose death rate relative to non-Hispanic White.

Another demographic control variable is measured as the percentage of the population living in a rural area, which is taken from County Health Rankings from the year 2010. While the variable data for percent rural is from 2010 and seems to be older, the 2020 data has yet to be released and should not have drastically changed from 2010. I predict that a higher percentage of rural will be associated with a higher premature age-adjusted death rate and drug-overdose death rate. The last demographic control variable is percentage female, measured as the percentage of the population who is female, which is taken from County Health Rankings in the year 2019. I predict that the higher the percentage female will be associated with a lower premature age-adjusted death rate and drug-overdose death rate.

The last control variables measured for this study are region dummy variables. The region dummy variables used include West, Midwest, Northeast and South, all of which are Census regions. South is the omitted region variable. I predict that the premature age-adjusted death rate and drug-overdose death rate will be lower in the West, Midwest, and Northeast, relative to the South.

To interpret the relationship between the risky behaviors, as well as the control variables with both the premature age-adjusted death rate and the drug-overdose death rate, two OLS regression were run. The first regression examines the relationship between the premature age-adjusted death rate and the independent variables.

$$\text{Premature age-adjusted death rate}_i = \beta_0 + \beta_1 smokers_i + \beta_2 excessivedrinking_i + \beta_3 opioiddispensingrate_i + \beta_4 obesity_i + \beta_5 chlymadiarate_i + \beta_6 fairorpoorhealth_i + \beta_7 medianhouseholdincome_i + \beta_8 violentcrime_i + \beta_9 unemploymentrate_i + \beta_{10} longcommutes_i + \beta_{11} hsgradute_i + \beta_{12} somecollege_i + \beta_{13} bachelors_i + \beta_{14} jailpopulation_i + \beta_{15} non\text{-}hispanicblack_i + \beta_{16} hispanic_i + \beta_{17} asian_i + \beta_{18} americanindian_i + \beta_{19} hawaiiannative_i + \beta_{20} rural_i + \beta_{21} female_i + \beta_{22} west_i + \beta_{23} midwest_i + \beta_{24} northeast_i + \mu_i.$$

The second regression examines the relationship between the drug-overdose death rate and the risky behaviors and control variables.

$$\text{Drug-overdose death rate}_i = \beta_0 + \beta_1 smokers_i + \beta_2 excessivedrinking_i + \beta_3 opioiddispensingrate_i + \beta_4 obesity_i + \beta_5 chlymadiarate_i + \beta_6 fairorpoorhealth_i + \beta_7 medianhouseholdincome_i + \beta_8 violentcrime_i + \beta_9 unemploymentrate_i + \beta_{10} longcommutes_i + \beta_{11} hsgradute_i + \beta_{12} somecollege_i + \beta_{13} bachelors_i + \beta_{14} jailpopulation_i + \beta_{15} non\text{-}hispanicblack_i + \beta_{16} hispanic_i + \beta_{17} asian_i + \beta_{18} americanindian_i + \beta_{19} hawaiiannative_i + \beta_{20} rural_i + \beta_{21} female_i + \beta_{22} west_i + \beta_{23} midwest_i + \beta_{24} northeast_i + \mu_i.$$

Results

This section will discuss the various tests run for each regression as well as discussing the results from each regression. Heteroskedasticity was present among both regressions, so robust standard errors were used. Also, multicollinearity was not a concern. Below is the table which shows the results from both regressions

Table 1: Results

	Premature Age-Adjusted Death Rate	Drug-Overdose Death Rate
Constant	207.5*** (68.50)	-22.20 (16.58)
Percent Smokers	5.658*** (1.167)	1.313*** (.2401)
Percent Excessive Drinking	-3.852*** (.5037)	-.5441*** (.1139)
Opioid Dispensing Rate	.4125*** (.0655)	.0281*** (.0104)
Percent Adults with Obesity	.0044 (.3406)	-.1905*** (.0725)
Chlamydia Rate	.0264* (.0519)	-.0049** (.0024)
Percent Fair or Poor Health	4.944*** (1.099)	-.3313 (.2557)
Median Household Income	-.0012*** (.0001)	-.00006 (.00004)
Violent Crime Rate	.0515*** (.0086)	.0105*** (.0026)
Unemployment Rate	-1.718 (1.134)	1.390*** (.2592)
Percent Long Commutes- Driving Alone	.6546*** (.1239)	.3154*** (.0337)
Percent Population age 25+, high school graduate	-.0838 (.5397)	.4341*** (.1241)
Percent of Population age 25+, some college no BA	.6105 (.5105)	.0974 (.1175)
Percent Population age 25+, bachelors or more	-2.106*** (.5005)	.0974*** (.1175)
Jail Population	-.0061*** (.0015)	-.00005 (.0003)
Percent Non-Hispanic Black	-.0463 (.2357)	-.0924** (.0425)
Percent Hispanic	-.8752*** (.2340)	-.0346 (.0509)
Percent Asian	.3007 (.6250)	-.2682*** (.0991)
Percent American Indian & Alaska Native	2.947*** (.4006)	-.0581 (.0842)
Percent Native Hawaiian/Other Pacific Islander	-3.826* (2.228)	-.4026 (.3716)
Percent Rural	-.1664** (.0759)	-.1354*** (.0196)
Percent Female	2.44*** (.8558)	.1479 (.1919)
West	-24.35*** (4.614)	3.173*** (1.085)
Midwest	-21.13*** (3.811)	.2808 (.9089)
North-East	-17.62***	5.481***

	(4.450)	(1.129)
R-squared	0.7462	0.2718
Number of Observations	2,801	1,680
F-Stat	331***	22.23***

Note: Robust standard errors for independent variables are shown in parentheses. The symbols *, **, ***, correspond to a 10%, 5%, and 1% level of significance.

I begin by discussing the results from the premature age-adjusted date rate regression and will then move on to the drug-overdose death rate regression. The first regression has 2,801 observations and an R-squared value of 0.7462. The R-squared value shows that the model can describe 74.62% variation in the premature age-adjusted death rate.

The percent of smokers has a positive and statistically significant association with the premature age-adjusted death rate at the 1% level. Specifically, a 1 percentage point increase in the percentage of smokers is associated with 5.65 more premature age-adjusted deaths per 100,000 population. This result confirms the predicted relationship that more smokers within a county lead to more premature deaths.

Next, the percent of excessive drinking has a negative and statistically significant correlation with the premature age-adjusted death rate at the 1% level. Results indicate that a 1 percentage point increase in the percentage of people reporting heavy or binge drinking is associated with 3.85 less premature age-adjusted deaths per 100,000 population. This result does not confirm the predicted relationship stating that a higher percentage of excessive drinking would lead to more premature deaths, however the results show that a higher percentage of excessive drinking is associated with a lesser number of premature deaths. No county exceeded a value greater than 31% for the percentage of the population who report heavy or binge drinking. Excessive drinking is a risky behavior that can cause a variety of detrimental health outcomes; however, these health outcomes do not always lead to premature death or death from drugs, which is why excessive drinking may not increase premature deaths within a county.

Another risky behavior that was statistically significant at the 1% level and had a positive association with the premature age-adjusted death rate was the opioid dispensing rate. The results indicate that 1 additional prescription per capita is associated with 41.25 additional premature deaths per 100,000 population, meaning that a higher number of prescriptions per person increases the number of premature deaths. This result confirms the predicted relationship that a higher dispensing rate will lead to more premature deaths.

Surprisingly, the percentage of adults aged 20 and over who report a body mass index (BMI) greater than or equal to 30 kg/m^2 was not statistically significant to the premature age-adjusted death rate. The last variable pertaining to risk behaviors is the chlamydia rate, which was positive and statistically significant at the 10% level, indicating that 100 additional chlamydia cases are associated with 2.64 more premature age-adjusted deaths per 100,000 population. While chlamydia itself is not causing deaths directly, it can be a proxy for increased morbidity and mortality, especially as seen with infertility, cervical cancer, thus leading to premature deaths. This result confirms the predicted relationship because additional chlamydia cases within a county can lead to more premature deaths. Also, higher chlamydia cases within a county could be due to increased screening or reporting by clinics or doctors, which in turn could be a good factor, since more individuals are getting treatment for the STI.

The percentage of the population who reported fair or poor health was positively and statistically significant at the 1% level. The results indicate that a 1 percentage point increase in the share of people reporting fair or poor health is associated with 4.9 more premature age-adjusted deaths per 100,000 population. This result confirms the predicted relationship that more people who report fair or poor health is associated with increases the number of premature deaths within a county.

Median household income had a negative and statistically significant relationship with the premature age-adjusted death rate at the 1% level. The results indicate that a $1000 increase in the median household income is associated with a 1.2 decrease in the premature age-adjusted death rate. This result supports the predicted relationship that a higher median household income leads to lower premature deaths within a county.

A variable that was positive and statistically significant to the premature age-adjusted death rate at the 1% level is the violent crime rate. The results explain that 100 additional violent crimes per capita is associated with 5 more premature deaths per 100,000 population. The results for the violent crime rate support the initial predicted relationship that more violent crime within a county lead to more premature deaths. Not statistically significant within the regression is the unemployment rate. However, the percentage of the population who drive alone on long commutes had a positively and statistically significant association with the premature age-adjusted death rate. The results infer that a 1 percentage point increase in people driving to work alone who have a commute greater than 30 minutes is associated with .65 more premature age-adjusted deaths, per 100,000 population. The results confirm the predicted relationship that more people driving alone on their long commutes to work will lead to more premature age-adjusted deaths within a county. As described by Blake-Gonzalez et al. (2020), a longer commuting time to work can impose a more emotional, temporal, and financial costs to an individual, which could increase the number of premature deaths within a county.

While interpreting the educational variables, it is important to note that the percentage of the population aged 25 and older who are high graduates and the percentage of the population aged 25 and older who have some college education but did not obtain a bachelor's degree are not statistically significant to the premature age-adjusted death rate. Negative and statistically significant to the premature age-adjusted death rate at the 1% level is the percentage of the population aged 25 and older who have a bachelor's degree or higher. These results indicate that a 1 percentage point increase in people who have a bachelor's degree or greater is associated with 2.1 less premature deaths, per 100,000 population, relative to the percentage of the population who does not have a high school education. These results confirm the predicted relationship that people who have a bachelor's degree or higher have less premature deaths compared to people who did not complete their high school education.

Surprisingly, the jail population had a negative association with the premature age-adjusted death rate at the 1% significance level. The results indicate that 1 additional person in jail is associated with .006 less premature age deaths, per 100,000 population. These results reject the expected relationship that a higher jail population would lead to higher premature deaths, however, individuals in jail could lower the death rate due to their limited resources that could relate to risky behaviors, such as tobacco, opioids, and alcohol, which could lead to fewer deaths. These results differ from the results found by Blake-Gonzalez et al. (2020) or Nostrati et al. (2019) who both agreed that incarceration tends to have a disruptive impact on families and communities, which would increase the death rate.

Race can play an important role when discussing premature death, as mentioned by previous literature. Surprisingly, both the percentage of the population who is non-Hispanic black and the percentage of the population who is Asian was not statistically significant within the regression. However, the percent of the population who is Hispanic is statistically significant at the 1% level and negatively associated with the premature age-adjusted death rate, indicating a 1 percentage point increase in the Hispanic population is associated with .87 less premature deaths per 100,000, relative to the percent of non-Hispanic white. These results confirm the expected relationship that a higher Hispanic population leads to less premature deaths compared to the non-Hispanic white population. The results for the percent Hispanic are like results found from Chan et al. (2014) that discuss how Hispanics have lower mortality rates relative to non-Hispanic whites. Rejecting the predicted relationship, the negative association of the percentage of the population who is American Indian or Alaskan Native is statistically significant at the 1% level to the premature age-adjusted death rate. These results indicate that a 1 percentage point increase in the population who is American Indian or Alaskan Native is associated with 2.9 more premature deaths per 100,000 population, relative to non-Hispanic whites. These results can be explained because American Indian or Alaska native tend to have higher death rates compared to other races. The last measurement of race is the percent of the population who is native Hawaiian or other pacific islander which is negative and statistically significant at the 10% level to the premature age-adjusted death rate, supporting the predicted relationship. The results explain that a 1 percentage point increase in native Hawaiian or other pacific islander is associated with 3.8 less premature deaths per 100,000 population, relative to non-Hispanic white.

The percent rural within the first regression is negatively associated and statistically significant at the 5% level, indicating that a 1 percentage point increase in the rural population leads to .16 less premature deaths, per 100,000 population, rejecting the expected relationship that more ruralness leads to more premature deaths. Similarly, the percent female rejects the expected relationship because it is positively correlated with the premature age-adjusted death rate at the 1% level. Results infer that a 1 percentage point increase in the percent of the female population is associated with 2.44 more premature deaths, per 100,000 population.

The last control variables are the Census region dummy variables: West, Midwest and Northeast. All three variables are statistically significant at the 1% level and negatively associated with the premature age-adjusted death rate, confirming the predicted relationship that counties located in the West, Midwest or Northeast will have fewer premature deaths, relative to the South.

The second regression has less observations compared to the first regression, with total observations equaling 1,680. The observations for the second regression are so much lower because many counties did not have data on the drug-overdose death rate. The R-squared value is 0.2718 which means that the model describes 27.18% variation in the drug-overdose death rate.

The percent of smokers has a positively and statistically significant association with the drug-overdose death rate at the 1% level. The results indicate that a 1 percentage point increase in the percentage of smokers is associated with 1.31 more drug-overdose deaths per 100,000 population. These results confirm the predicted relationship that more smokers in a county lead to more drug-overdose deaths.

The percentage of excessive drinking has a negatively and statistically significant association with the drug-overdose death rate at the 1% level. The results indicate that a 1 percentage point increase in the people who report heavy, or binge drinking is associated with .54 less drug-overdose deaths per 100,000 population. Like the first regression, the results within this regression do not match the predicted positive relationship between the percent of excessive drinking and the drug-overdose death rate, but rather show how more excessive drinking leads to less drug-overdose deaths within a county. Once again, excessive drinking is a risky behavior that can cause a variety of detrimental health outcomes; however, these health outcomes do not always lead to premature death or death from drugs, which is why excessive drinking may not increase the number of drug-overdose deaths within a county.

On the other hand, as predicted, the opioid dispensing rate has a positive and statistically significant relationship with the drug-overdose death rate, at the 1% level. The results indicate that 1 additional prescription per capita is associated with 2.81 more drug-overdose deaths per 100,000 population, specifically meaning that a higher number of prescriptions per person contributes to a higher drug-overdose death rate per county. Statistically significant at the 1% level and negative is the percentage of adults aged 20 and over who report a body mass index (BMI) greater than or equal to 30 kg/m^2, indicating that a 1 percentage point increase in the percent of adults with obesity is associated with .19 less drug-overdose deaths per 100,000 population. The results indicate that the higher percent of adults with obesity corresponds to less drug-overdose deaths within a county, rejecting the predicted relationship.

The last risky behavior is the chlamydia rate which is negatively and statistically significant at the 5% level. The results indicate that 100 additional chlamydia case is associated with .49 less drug-overdose deaths, meaning that more chlamydia cases within a county reduces the drug-overdose death rate. Chlamydia itself does not directly cause deaths, yet it can be viewed as a proxy for increased morbidity and mortality, as seen with infertility and cervical cancer, which in turn can lead to more deaths, but within this scenario the chlamydia cases is associated with a reduction in the number of drug-overdose deaths within a county. This could be a result of individuals that have chlamydia do not use partake in other risky behaviors such as drug usage, which would lead to less drug-overdoses within a community.

The percentage of the population who report fair or poor health was not statistically significant to the drug-overdose death rate. Similarly, median household income was not statistically significant to the drug-overdose death rate. However, an important economic variable positive and statistically significant at the 1% level in determining drug-overdose deaths is the violent crime rate. The results explain that 100 additional violent crimes per capita is associated with 1 additional drug-overdose death per 100,000 population, supporting the initial claim that additional violent crimes within a county lead to higher drug-overdose deaths, meaning that more crime within a county lead to more deaths from drugs. The unemployment rate is positively correlated and statistically significant at the 1% level to the drug-overdose death rate. Results infer that a 1 percentage point increase in unemployment is associated with 1.39 more drug-overdose deaths per 100,000 population, which confirms the original predicted relationship that more unemployment within a county lead to more drug-overdose deaths.

The percentage of people who have long commutes who drive alone is statistically significant at the 1% level and positively correlated to the drug-overdose death rate. The result shows that a 1 percentage point increase in people who drive alone during the long commutes is associated with .31 more drug-overdose deaths per 100,000 population, confirming the predicted hypothesis that more people driving long commutes alone will lead to more drug-overdose deaths. As mentioned by Blake-Gonzalez et al. (2020) individuals who have a large disutility to longer commutes or could not find a job closer to their residence could turn to drug usage, increasing the amount drug-overdoses within a community.

The percent of the population aged 25 and older who have some college education but did not obtain their bachelor’s degree is not statistically significant to the drug-overdose death rate. However, the percentage of the population aged 25 and over who graduated college is positive and statistically significant to the drug-overdose rate, at the 1% level. Results indicate that a 1 percentage point increase in people who have graduated high school is associated with .43 more drug-overdose deaths per 100,000 population, relative to the percentage of the population with no high school education. These results do not confirm the predicted relationship that high school graduated individuals have fewer drug-overdose deaths compared to individuals who did not complete their education. Finally, positive, and statistically significant at the 1% level to the drug-overdose death rate is the percent of the population aged 25 and older who have a bachelor's degree or higher. Results indicate that a 1 percentage point increase in the percent of the population who have a bachelors or higher degree is associated with .09 more drug-overdose deaths, per 100,000 population relative to the percentage of the population with less than a high school education. These results also reject the predicted relationship that more college educated individuals would have fewer drug-overdose deaths compared to individuals who did not complete high-school. While it would be assumed that individuals who have a higher educational attainment level compared to individuals who do not have a high education, would have a lesser number of drug-deaths, an explanation could be that they have a higher income which could lead to drugs available for usage and thus overdoses. Within the regression, the jail population was not statistically significant to the drug-overdose death rate.

Comparing the racial outcomes for the drug-overdose death rate regression, the percent non-Hispanic black was statistically significant and negative to the drug-overdose death rate at the 5% level. Results indicate that a 1 percentage point increase in non-Hispanic black population is associated with .09 fewer drug-overdose deaths, per 100,000 population, compared to the non-Hispanic white population. Not significant within this regression to the drug-overdose death rate is percent Hispanic, percent American Indian or Alaskan Native and percent native Hawaiian or another pacific islander. However, the percent of the population who is Asian is negatively associated with the drug-overdose death rate at the 1% level, confirming the expected relationship. The results illustrate that a 1 percentage point increase in the Asian population is associated with .26 less drug-overdose deaths per 100,000 population, relative to non-Hispanic whites.

The percent of the population that is rural is statistically significant at the 1% level and negatively associated with the drug-overdose death rate, which rejects the expected positive relationship. The results indicate that a 1 percentage point increase in the rural population is associated with .13 fewer drug-overdose deaths, per 100,000 population. Within the second regression, the percent of the population who is female was not statistically significant to the drug-overdose death rate.

The dummy variable Midwest was not statistically significant to the drug-overdose death rate. However, West and Northeast are positively associated with the drug-overdose death rate and statistically significant at the 1% level, indicating that counties located in the West or Northeast are more drug-overdose deaths compared to counties located in the South, rejecting the predicted relationship.

Conclusion

The causes of different mortality rates are abundant and ever changing due to the variety of factors that can influence death. However, this paper directly studied the impacts that risky behaviors have on the premature age-adjusted death rate as well as the drug-overdose death rate at the county level. Using county level data to examine risky behaviors on the different measurements of mortality helps to gauge death rates, especially drug-overdoses within the United States. This paper asked the question: Do risky behaviors impact the premature age-adjusted death rate and the drug-overdose death rate. The hypothesis stated that at the county level, an increase in risky behaviors will increase the premature age-adjusted death rate and the drug-overdose death rate, controlling for several demographic, region, and economic variables.

The results conclude that indeed, some of the risky behaviors did increase the number of premature deaths and drug-overdose deaths within a county, yet some of the risky behaviors decreased the number of premature and over-dose deaths. The main takeaways from both regressions are that a higher percentage of smokers within a county lead to more premature deaths and drug-overdose deaths. However, a higher percentage of excessive drinking leads to less premature deaths and drug-overdose deaths within a county. The higher number of opioids per person leads more premature deaths and drug-overdose deaths. The higher percent of the adult population with obesity leads to more drug-overdose deaths. Yet, more chlamydia cases within a county lead to more premature deaths but less drug-overdose deaths. Most of the risky behaviors follow the projected hypothesis that risky behaviors will increase the number of premature deaths and drug-overdose deaths within a county, including percentage of the population who are smokers, the opioid dispensing rate. However, the percentage of the population who report heavy or binge drinking and the percentage of the adult population who report a BMI greater than or equal to 30 kg/m2 reduce the number of premature deaths and drug-overdose deaths at the county level. The chlamydia rate, as seen by the results, is associated with more premature deaths yet less drug-overdose deaths, indicating an ambiguous effect on the death rates.

This study had some limitations, to begin, many of the counties did not have data for the drug-overdose death rate, which caused for a lesser number of observations for the second regression. By expanding the number of years used within the study, I could use panel data to measure the impact of risky behaviors over a long period of time and if they are influential to the premature age-adjusted death rate and drug-overdose death rate. These additional years would also increase the number of observations, especially for the drug-overdose death rate variable.

Another further point of research would be to also look at other countries and how their results compare with the results from the United States counties.

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Appendix

Table 2: Description and source of variables

Variable	Description	Mean	Standard Deviation	Minimum	Maximum
Premature age-adjusted death rate (1)	Number of deaths among residents under age 75 per 100,000 population (age-adjusted).	409.03	115.06	128.70	1107.49
Drug-overdose death rate (1)	Number of drug poisoning deaths per 100,000 population.	22.77	12.50	3.81	126.72
Percent smokers (1)	Percentage of adults who are current smokers (age-adjusted).	21.32	4.15	7.07	44.57
Percent excessive drinking (1)	Percentage of adults reporting binge or heavy drinking (age-adjusted).	19.09	3.43	6.45	31.01
Opioid dispensing rate (2)	Number of prescriptions dispensed per 100 persons	38.78	30.91	0	406.7
Percent adults with obesity (1)	Percentage of the adult population (age 20 and older) that reports a body mass index (BMI) greater than or equal to 30 kg/m2.	33.44	5.97	11	58.9
Chlamydia rate (1)	Number of newly diagnosed chlamydia cases per 100,000 population.	410.81	289.02	37.3	5215.5
Percent poor or fair health (1)	Percentage of adults reporting fair or poor health (age-adjusted).	20.11	5.11	8.59	41.91
Median household income (1)	The income where half of households in a county earn more and half of households earn less.	55,713.46	14490.23	24,732	151,806
Violent crime rate (1)	Number of reported violent crime offenses per 100,000 population.	251.90	192.50	0	1820
Unemployment rate (1)	Percentage of population ages 16 and older unemployed but seeking work. Percentage of population ages 16 and older	4.00	1.48	.7380	19.31

	unemployed but seeking work.				
Percent long commutes-driving alone (1)	Among the percentage of the workforce that drives alone to work, the percentage that commute more than 30 minutes	31.96	12.66	0	73.4
Percent population age 25+, less than high school education (3)	Percentage of the population age 25+ who has less than a high school education	13.80	6.47	1.1	58.6
Percent population age 25+, high school graduate (3)	Percentage of the population age 25+ who is a high school gradate	34.41	7.15	7.3	54.9
Percent population age 25+, some college no BA (3)	Percentage of the population age 25+ who has some college education but no bachelor's degree	30.56	5.13	8.8	46.7
Percent population age 25+, bachelors or more (3)	Percentage of the population age 25+ who have a bachelor's degree or higher	21.21	9.28	4.7	78.1
Jail population (4)	The percent of residents aged 15-64 in jail per 100,000 population	234.90	625.58	0	17208
Percent non-Hispanic black (1)	Percentage of the population who is non-Hispanic black	9.00	14.28	0	85.87
Percent non-Hispanic white (1)	Percentage of the population who is non-Hispanic white	75.78	20.21	2.68	97.83
Percent Hispanic (1)	Percentage of the population who is Hispanic	9.77	13.86	.647	96.35
Percent Asian (1)	Percentage of the population who is Asian	1.57	2.95	0	43.36
Percent American Indian & Alaska native (1)	Percentage of the population who is American Indian or Alaskan native	2.38	7.76	0	92.41
Percent native Hawaiian/Other Pacific Islander (1)	Percentage of the population who is native Hawaiian or other Pacific Islander	.145	.968	0	48.83
Percent rural (1)	Percentage of the population that is rural	58.58	31.48	0	100
Percent female (1)	Percentage of the population who is female	49.88	2.26	26.51	57

West (5)	A county located in Census region West	.142	.249	0	1
Midwest (5)	A county located in Census region Midwest	.335	.472	0	1
Northeast (5)	A county located in Census region Northeast	.069	.253	0	1
South (5)	A county located in Census region South	.4525	.497	0	1

Sources: (1) County Health Rankings, (2) CDC, (3) United States Census Bureau, (4) Vera Institute of Justice, (5) United States Census Regions