

**The Durability of Rurality:
Connecting Deaths of Despair and Livelihood Characteristics in U.S. Counties**

by

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Abstract

Despite the decrease in overall mortality rate, drug related overdose deaths in the U.S. continue to increase. Factors such as unemployment and the decline of traditional livelihoods have been suggested as potential causes of deaths of despair among rural communities. However, varying definition of rurality challenge the authenticity of such relationships. The study draws on Durkheim and Marx to anticipate conditions that link livelihoods and deaths of despair through anomie and alienation. Thus, the objective of this empirical study is to examine the durability of the relationship between drug related overdose deaths and shifting sources of livelihood as moderated by different definitions of rurality. Rurality is treated as a moderator variable, one that affects the strength of relationship between independent and dependent variables.

Data on the dependent variable, age adjusted drug poisoning mortality rate, an indicator of Deaths of Despair (DoD), was obtained from National Center for Health Statistics (NCHS) - Drug Poisoning Mortality by County: United States. Measures of livelihood dependence, unemployment rate, poverty rate, education, and other selected control variables were obtained from United States Department of Agriculture-Economic Research Service (USDA-ERS) Atlas of Rural and Small-Town America and American Community Survey (ACS) 5-Year Data. Five definition of rurality were purposefully selected from Office of Management and Budget (OMB), United States Department of Agriculture Economic Research Service (USDA-ERS) and the U.S. Census Bureau. Pearson correlation and multiple linear regression analysis were used to test hypotheses.

Result showed that average drug poisoning mortality rate increased from 8.4 percent in 2007 to 16.7 percent in 2016. At the same time change in unemployment percent was only 0.36

from 2007 to 2016. The observed correlations between dependent and independent variables were weak or moderate (< 0.5). Results showed that despite slight variations, the relationship between sources of livelihood and drug related overdose death rates were relatively stable across different definition of rurality. Further, keeping other variables constant, unemployment rate and source of livelihood (construction and mining) had a significant positive association with drug related overdose death. For other variables, higher percentage of white non-Hispanic, older age, and poverty rate in a county were significantly associated with drug related overdose deaths. On the other hand, education level, marital rate, fertility rate, having insurance, and higher level of income for a county were significantly associated with lower drug related overdose death rates. Gender ratio was not a significant predictor of drug related overdose death.

In conclusion, despite slight variations the relationship between the unemployment and DoD was relative stable across different definition of rurality. In some instances, the relationship between livelihood and deaths of despair was sharper in the most rural category of counties, but this pattern was neither marked nor consistent. This finding was in contrary to other studies. Future study should examine the durability of the rural definition using other more granular units of analysis such as tracts or zipcode areas.

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List of Abbreviations

ACS	American Community Survey
CDC	Centers for Disease Control and Prevention
CTEW	Construction trade and extractor worker
COVID-19	Coronavirus disease 2019
DoD	Deaths of Despair
FIPS	Federal Information Processing Standards
GED	General Education Diploma
MFI	Median Family Income
NCHS	National Center for Health Statistics
OMB	Office of Management and Budget
PMRs	Proportional mortality rate
RUCC	Rural-Urban Continuum Code
UACE	Urban area census code
U.S.	United States of America
USDA	United States Department of Agriculture
USDA-ERS	United States Department of Agriculture-Economic Research Service
WNHs	White Non-Hispanics

Chapter 1 Introduction

1.1 Background and Problem Statement

The U.S. mortality rate has slowed down or even in some cases, become negative in some population groups over the past few years (Case and Deaton 2015, Ma et al. 2015). Although mortality rates for all other demographic groups continued to decline at a rate of 2% per year from 1998 to 2017, the mortality rate for middle-aged White Non-Hispanics (WNHs) age 45-54 rose by half a percent annually (Case and Deaton 2017). The primary reason for such a mortality increase was due to the marked increases in death due to drug overdoses, suicides, and alcohol-related liver mortality in this period (Case and Deaton 2017, Case and Deaton 2020, Jalal et al. 2018, Olfson et al. 2019).

Drug overdose-related mortality rates in the United States increased by 250 percent from 6.1 deaths per 100,000 in 1999 to 21.7 in 2017 (Hedegaard et al. 2020) though they decreased a point (4.6%) from 2017 (21.7 per 100,000) to 2018 (20.7 per 100,000) (Center for Disease Control and Prevention 2020). Overall, deaths from overdose increased by more than fourfold, mortality from alcohol-related liver disease rose by 50% (Case and Deaton 2015). Rates of suicide increased by approximately 37% for those with a high school degree or less (Case and Deaton 2015). Additionally, between 2005 to 2014, the national rate of opioid-related inpatient hospital stays increased by 64%, and the rate of opioid-related emergency department visits increased by 99% (Weiss et al. 2016).

Deaths of Despair

All these deaths, drug overdose, suicides, and alcohol-related liver mortality, are closely related and show great unhappiness with life; thus, the term was coined as “deaths of despair”

(DoD) (Case and Deaton 2020). DoD is a convenient label indicating the link with unhappiness, the link with mental or behavioral health, and the lack of any infectious agent, but it is not intended to identify the specific causes of despair (Case and Deaton 2020).

Declining livelihoods as reflected in unemployment rate have been identified as one of the potential cases of despair among rural population (Betz and Jones 2018, Monnat 2018, Strumpf et al. 2017). However, varying definitions of rurality pose a significant challenge in establishing such relationships.

Rurality

Rural definitions are important for government functions related to rural policymaking, regulation, and program administration (Rural Health Information Hub 2019). Such definitions are used to determine the eligibility for federal rural programs, in the implementation of programs, laws that concern rural areas, and for research and data collection (Rural Health Information Hub 2019). All require statistical consistency and accuracy, as well as validation (Rural Health Information Hub 2019). Thus, with varying definitions of rurality, the interpretation of impact of DoD among rural communities become difficult.

There are several challenges associated with the varying definition of rurality. First, the definition of rural as something that is not Urban or/and with a population below a certain level is problematic. This is because, in the U.S., so many people live in areas that are not clearly rural or urban, thus seemingly small changes in the way rural areas are defined can have large impacts on who and what are considered rural (United States Department of Agriculture Economic Research Service 2019).

Secondly, rurality is often defined in terms of counties or county-equivalents (e.g., parishes, boroughs). These are standard building blocks for publishing economic data and for conducting research to track and explain regional population and economic trends that might be misleading with the various definitions (United States Department of Agriculture Economic Research Service 2019).

Third, the share of the U.S. population defined as rural, and its socioeconomic characteristics varies substantially. For instance, holding the population threshold constant at the minimum level of 2,500 people, but moving from an administrative to a land-use definition, drops the U.S. rural population by a third, from 31 to 21 percent (Cromartie and Bucholtz 2008).

Fourth, given that rural definitions based on administrative boundaries include larger shares of what could be classed as suburban areas, the education and income levels of their populations are closer to those of the general U.S. population. However, for non-metro areas, the share of the rural population with a college degree drops from 28 to 18 percent, and the average household income drops from \$56,000 to \$40,000, and so on (Cromartie and Bucholtz 2008) . However, little research has systematically evaluated the impact of the varying definition of rurality. Thus, in this study, we aim to quantify how the relationship between the county livelihood characteristics and drug overdose deaths, an indicator for DoD across varying definitions of rurality.

1.2 Purpose of the Study

This study examines the change DoD as a function of employment decline while considering the mediating effect of selected definitions of rurality in U.S. counties controlling for key sociodemographic factors. It seeks to clarify the moderating role of different definitions of rurality as it conditions our understanding of the sources of DoD.

1.3 Objectives

This empirical study will examine the durability of the relationship between changes in DoD and employment decline across different definitions of rurality.

1. Develop a conceptual framework for understanding DoD.
2. Identify central means of characterizing rurality of U.S. counties.
3. Test hypotheses connecting sources of livelihood to indicators of DoD in U.S. counties.
4. Assess the policy and research consequences of alternative rurality definitions.

1.4 Outline of the Study

The study is structured as follows. Chapter one comprises the introduction, which includes the background and problem statement, propose of the study, context, and objectives of the study. Chapter two provides a conceptual framework that draws the relationship between the DoD and a decrease in employment with the mediating effects of rurality as well as other socioeconomic variables. Chapter three describes the research method. Chapter four tests the hypotheses and presents the statistical results. Chapter five summarizes the main points and implications of the study.

Chapter 2 Conceptual Framework

This chapter provide an overview of previous research and conceptualizations of DoD and relationships to county characteristics in the context of different definitions of rurality.

2.1 Durkheim on Suicide

French sociologist Émile Durkheim describes the tendency to suicide as neither defined by the organic-psyche constitution of individuals nor the nature of physical environment, but rather depends upon social cause and should be considered a collective phenomenon (Durkheim 2005). Based on the social condition responsible, he categorized suicide into four different types that represent extremes on two continua: social integration and social regulation of need (Figure 1).

Egoistic Suicide: Egoistic suicide occurs when an individual does not feel they are well integrated into society (Durkheim 2005, Moore 2017). An individual feels like they are not a part of the community as well as think that the community also do not consider them as the part of the society, or excessive individualism where individual ego asserts itself in the face of the human ego (Durkheim 2005, Moore 2017). Such integration can come from religion. He observed that stronger the integration among the religious community and individual, greater is its preservative value (Durkheim 2005).

Similarly, he also suggests that women commit suicide much less than men as they are not educated, and their conduct are governed by fixed belief and has no great intellectual needs (Durkheim 2005). Moreover, he further explains that suicidal tendency is higher among the educated because it weakened traditional beliefs and a state of moral individualism is a result (Durkheim 2005).

Unmarried persons and families without children seem to commit suicide less than married ones but the factors also should be adjusted for their age. The data indicate that after age 20, being married has a preservative effect on suicide (Durkheim 2005, Kposowa 2000, Smith, Mercy and Conn 1988). One of the reasons might be due to the influence of family, or domestic environment, which will neutralize difficult situations. It might be due to the matrimonial selection, i.e., individuals with low fortune are not married and have higher suicide rates (Durkheim 2005). Homes with children seem to reduce untoward effects of marriage (Durkheim 2005). He also proposes that suicide decrease with increase in family density because of the bonds of communal life. In summary, suicide varies inversely to the degree of integration into religious society, domestic society, and political society. In other words, the integration of the individual into primary groups and the broader society represent ties that inhibit suicide (Durkheim 2005).

Altruistic Suicide: Altruistic suicide is the type of suicide when there is not enough individualism, and the weight of the society is brought to bear on an individual to destroy himself or herself (Durkheim 2005). Now, individualism (ego) is not individual but is exterior to itself, i.e., of a group in which individual participates. Public opinion does not formally require him/her to suicide but favors so. Altruistic suicide has been divided into three different categories: obligatory altruistic suicide, optional altruistic suicide, and acute altruistic suicide (Stack 2004). It has been observed that the suicide rate among soldiers is higher than that of the general population. The soldier's principle of action is external to himself, which is the quality of the state of altruism.

Anomic suicide: The third type of suicide results from a lack of societal regulation on individuals and consequently suffering (Durkheim 2005). In anomic suicide, the influence of

society is lacking, leaving them without checks in place. Uncertain futures or indeterminateness leads to a state of disturbance, disillusion, disappointment, agitation, and discontent, increasing the possibility of suicide. It is the anger and emotions, customarily associated with disappointment. A crisis such as economic crisis, loss of a job, or loss of family might ruin a person's life as he/she cannot live on a smaller footing. To spare his name and family the disgrace of bankruptcy leading to commit suicide, for example, DoD may be centrally tied to this condition.

Fatalistic suicide: In the opposite axis to anomic suicide is fatalistic suicide. Where there is too much regulation, blocked futures and passions violently choked by oppressive discipline may lead an individual to suicide (Durkheim 2005). This type of suicide occurs among very young husbands or among married women without children.

Durkheim's four types of suicide (after Pope 1976)

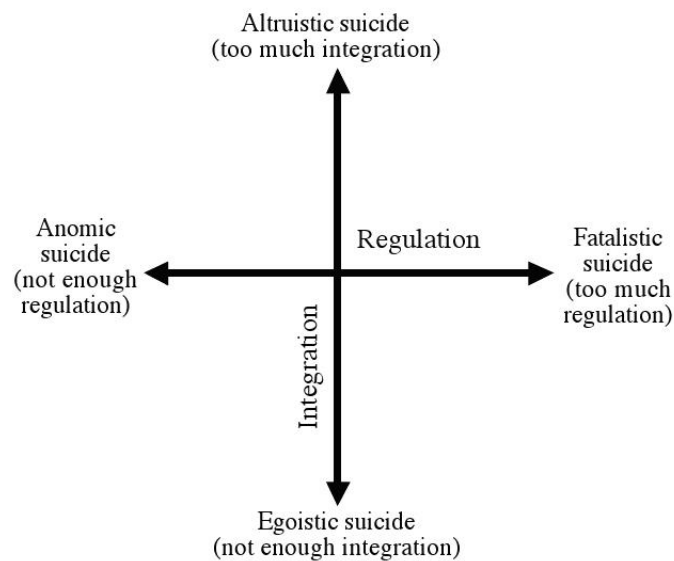


Figure 1 Durkheim's four types of suicide

Source: *Notes on Culture: Durkheim, Suicide*. URL: <http://notes-culture.blogspot.com/2017/10/durkheim-suicide.html>

2.2 Marx on Alienation

Karl Marx (1988), along with his coauthor (who) in their book “Economic and Philosophic Manuscripts of 1844 and the Communist Manifesto” suggest that capitalism has created two classes of individual in the society they property-*owners* and the property less-*workers* (Marx, Engels and Milligan 1988). The workers sink into the level of commodity that is inversely proportional to the power of the production, while capital is accumulated in the hand of few people. He argues that worker becomes all poorer the more wealth they produce and become cheaper commodity the more commodities he creates. Thus, underscoring the idea that labor not only produce commodities, it produces labor as a commodity (Marx, Engels and Milligan 1988). Alienation is the concept that individual is isolated from the society, work and sense of self (Marx, Engels and Milligan 1988, Sayers 2011). Various aspects of alienation may lead to deaths of despair.

Four Types of Alienation

Alienation from the object of production: This type of alienation describes the object that labor produces. The worker provides labor but has no power over the product and is alien to him/her. Workers realize that their labor is simply congealed within, is simply an object, and there is no bondage. This condition is also known as *objectification*. Marx in his book, “Economic and Philosophic Manuscripts of 1844 and the Communist Manifesto” (Marx, Engels and Milligan 1988) writes that"

“This fact expresses merely the object which labor produces—labor's product—confronts it as something alien, as a power independent of the producer. The product of labor is labor which has been congealed in an object, which has become material: it is the objectification of labor. Labor's realization is its

objectification. In the conditions dealt with by political economy this realization of labor appears as loss of reality for the workers; objectification as loss of the object and object-bondage; appropriation as estrangement, as alienation.” (pg. 71)

It so occurs that the worker realizes that there is no value of the labor, they are robbed of the product not only necessary for life but also necessary for work, also known as *estrangement*. The more workers expend their labor, the more powerful the objective world becomes. This condition creates stress over-against himself, the poorer he himself--his inner world-- becomes. The product exists in the individual; something that is alien or unconnected. Labor provides the means of life for the worker. Thus, the more the worker's labor appropriates the external world, the more he deprives himself of means of life. Becoming enslaved of his object, he receives work on the object as a means to support his life.

Alienation from the process or act of production: Secondly, the estrangement is not only manifested to the products of the labor, but also in the act of production or the process. Workers are not interested in the meaning of their actions, thus performing them in a mechanical way. This means labor is *external to the worker* i.e., putting labor into the product does not satisfy worker or make him happy, the physical and mental energy he/she puts into the product does not produce contentment, but rather mortifies the body and ruins the mind. Work is thus not voluntary but is coerced or *forced labor*. Alienation of labor appears in the fact that it is not his own, but *someone else's* and function independent of the worker. As a result, workers feel as animals fulfilling the basic needs of human life."

“...the fact that labor is external to the worker, i.e., it does not belong to his essential being; that in his work, therefore, he does not affirm himself but denies himself, does not feel content but unhappy, does not develop freely his physical

and mental energy but mortifies his body and ruins his mind...Its alien character emerges clearly in the fact that as soon as no physical or other compulsion exists, labor is shunned like the plague. External labor, labor in which man alienates himself, is a labor of self-sacrifice, of mortification... in the same way worker's activity is not his spontaneous activity. It belongs to another; it is the loss of his self." (pg. 74)

Alienation from self or species being: Human is a social animal and occur in the context of the social relation but in the capitalist society the workers are alienated from our "species being"-the very thing that distinguish human being form animal "Species being" (Marx, Engels and Milligan 1988).Works are reduced to the animal character merely to satisfy the materialistic needs. Work that distinguish human form other animals are robbed in capitalist society, as a result worker are robbed of humanity (Sayers 2011).

"Man is a species being, not only because in practice and in theory he adopts the species as his object (his own as well as those of other things), but—and this is only another way of expressing it—but also because he treats himself as the actual, living species; because he treats himself as a universal and therefore a free being." (pg.75)

Alienation from fellow men: This means that workers does not realize his potential, his craftsmanship are not valued resulting in alienation from himself. In the modern society we treat each other or fellow workers as an object to maximize someone's utility or benefit. He argued that even the sexual relation that is has the very nature of sensual manifestation has reduced to materialistic thing-where a human being treats other human being as an object, an instrument to

reach an end". The dislocation of livelihoods from automation, technical change, and international competition may be a central driver for DoD.

“The estrangement of man, and in fact every relationship in which man stands to himself, is first realized and expressed in the relationship in which a man stands to other men. Hence within the relationship of estranged labor each man views the other in accordance with the standard and the position in which he finds himself as a worker.” (pg.79)

Alienation and Suicide

Marx and Durkheim theories coincide with each other in the sense that they both indicate social structure as the factor influencing the suicide (Little 2008). For instant, Marx considers class struggle between Bourgeoisie and Proletariat as the social structure, whereas Durkheim consider the loss of social integration as a form of social structure.

On the other hand, there are differences between Durkheim and Marx in relation to suicide. Durkheim suggested that difference in the suicide is a symptom of an underlying of *levels of solidarity* i.e., ‘social integration’ and ‘social regulation’, between an individual and the society (Little 2008, Maskill et al. 2005). Higher or lower social integration or regulation thus has a relationship with the suicide. However, Marx suggests that social relations are founded on *equality and freedom* (Little 2008). He propose that alienation is the separation of the person from his/her nature as a free producer and creator, and separation of the person from natural sociality (Little 2008). Durkheim, however, see the ties that bind individuals to society through stable work, family, and communities as protective forces to DoD.

2.3 Factors Conceptually Related to Death's of Despair (DoD)

The focal concept of this study to understand the relationship between the drug poisoning mortality and the unemployment rate. Previous studies have highlighted the relationship between economic distress and drug-related deaths. Strumpf et al. (2017) suggested that though overall mortality in U.S. decreased during the Great Recession, the prescription drug-related overdose death increased in working-age adults in metropolitan areas (Strumpf et al. 2017). Monnat (2018) found higher drug related mortality among counties with great economic and family distress (Monnat 2018). Employment and wage growth are important protective factors for rural white males (Betz and Jones 2018). Recent reports suggest that increases in unemployment due to coronavirus disease 2019 (COVID-19) led to the increases in the DoD (Petterson and Westfall 2020). Selected antecedents to DoD are discussed in the following sections.

Unemployment and DoD

With globalization, changing technology, rising healthcare costs, and the shift from manufacturing to services, firms shed less educated labor (Stein et al. 2017). Destabilized livelihood are identified as the root cause of existential pain leading to reliance on narcotics resulting in drug overdose death, suicide, and alcohol-related deaths (Case and Deaton 2020, Holmes et al. 2020). Several authors have noted that unemployment has been repeatedly reported as a major risk factor for suicide using a variety of methodologies (Agerbo 2005, Blakely, Collings and Atkinson 2003b, Chen et al. 2010).

Unemployment may promote the vulnerability to suicidal behavior by adding to the impact of stressful life events and by amplifying other risk factors for suicide, such as mental illness and family conflict. There is an approximately twofold increase in suicide risk among the

unemployed (Kposowa 2001, Lewis and Sloggett 1998). On the other hand, some argue that poor mental health precedes and predicts both unemployment and suicide, thereby leading to a spurious link between unemployment and suicide (Blakely, Collings and Atkinson 2003b, Lewis and Sloggett 1998, Reeves et al. 2012). Historically, the epidemic of pain, suicide, and drug overdoses followed the financial crisis suggesting a strong tie to economic insecurity (Case and Deaton 2015).

Socioeconomic Factors and DoD

Socioeconomic factors such as low education, unemployment, low income, and disintegration of social and community support have contributed to the growing DoD. Education level was related to the DoD. The risk of dying a DoD had risen markedly, but only for those who did not hold a four- year college degree (Case and Deaton 2017, Case and Deaton 2020). Ninety percent of such deaths are among those who do not have a bachelor's degree. This might be because if you have a college degree, you earn more, can live a better life, and are better aware of the disease condition. The unemployment rate was also twice higher among those with a high school diploma than with a bachelor's degree (Case and Deaton 2020).

Stress, Hopelessness, and DoD

Stress and hopelessness of the labor market, as well as lower-paying jobs, are key drivers for distress (Stein et al. 2017). Rural areas have high relative densities of working-class whites, who experienced a loss of manufacturing jobs with subsequent permanent unemployment (Vierboom, Preston and Hendi 2019, Woolf and Schoomaker 2019). Similarly, the disintegration of community institutions, family dysfunction, poor social support, and addiction were also related to DoD (Holmes et al. 2020, Stein et al. 2017). It was no longer feasible to follow the family livelihood tradition, such as manufacturing or agriculture (Case and Deaton 2017).

Similarly, a decline in employment and income has reduced the prospect of marriage, undermined conceptions of masculinity, and the prospect of having children (Case and Deaton 2017, Sherman 2009).

Demographic Factors and DoD

Demographic factors, including age, gender, and race, have been associated with the DoD (Case and Deaton 2020, Stein et al. 2017). Case and Deaton, 2015 reported a marked increase in the all-cause mortality of middle-aged (45-54 year) white non-Hispanic men and women in the United States (Case and Deaton 2015, Case and Deaton 2017). For whites between the ages of 45 and 54, DoD tripled from 1990 to 2017 (Case and Deaton 2020). Males are always in the spectrum of higher death, twice as likely, as compared to females (Bohnert and Ilgen 2019, Case and Deaton 2020). Stein et al., 2015 reported that though age-adjusted premature death rate for adults declined by 8% between 1999 to 2001 and 2013 to 2015, age-adjusted death rate related to suicide, poisoning, and liver disease increased for a non-Hispanic working-class white population living largely in the rural areas (Stein et al. 2017).

Race and DoD

Case and Deaton, 2020 further also suggest that African Americans are much less likely to kill themselves than are white Americans; their suicide rates are currently about a quarter of those for whites (Case and Deaton 2020). Talented and well- educated young people have headed to the growing, successful, high-tech towns and cities, leaving low paid fewer skills working in the rural communities (Case and Deaton 2020). Rural communities are further challenged by globalization leading to the loss of skilled workers (Stein et al. 2017). The racial difference among such psychological aspects could also be observed with Hispanics tend to be

more resilient to negative shocks as well as poor blacks tend to be very optimistic as compared to poor whites who were very negative (Case and Deaton 2017).

Physical and Psychological Factors and DoD

Physical and psychological factors such as pain, loneliness, anxiety, stress, hopelessness, worthlessness, shame, and depression were other factors contributing to the rise in deaths (Case and Deaton 2017, Case and Deaton 2020, Rehder, Lusk and Chen 2019, Stein et al. 2017).

Unemployment leads to an increase in drug use, causing higher drug-related death (Blakely, Collings and Atkinson 2003b, Case and Deaton 2020).

Geographic Location and DoD

Drug-related death rates were also found to vary with geographic location. Appalachia, New England, Florida, and eastern Oklahoma, and the Southwest Desert saw the highest drug overdose death rate (Monnat 2018, Monnat et al. 2019, Monnat 2019, Rigg, Monnat and Chavez 2018). In 2018, the states with the highest rates of death due to drug overdose were West Virginia (51.5 per 100,000), Delaware (43.8 per 100,000), Maryland (37.2 per 100,000), Pennsylvania (36.1 per 100,000), Ohio (35.9 per 100,000), and New Hampshire (35.8 per 100,000) (Hedegaard et al. 2020).

There has been a shift in geographic pattern of poisoning deaths involving heroin from the west coast of the U.S. in the year 2000 to New England, the MidAtlantic region, and the Great Lakes and central Ohio Valley by 2014, suggesting a changing dynamic of drug-related mortality by region (Stein et al. 2017). In summary, geographical locale is associated with DoD.

Rurality and DoD

Further, rural areas have seen the greatest impact of DoD. The overall rate of drug death in rural communities is higher, with more economic disadvantages, greater concentrations of the

blue-collar and service sectors and professions, and higher rates of opioid prescribing (Monnat et al. 2019). Fatal overdoses from opioids have increased by over 700 percent in both micropolitan and rural (noncore) counties, and by nearly 400 percent in metropolitan ones (Peters et al. 2019). Stein et al. (2017) report that rural areas with higher densities of working-class WNHs saw the largest increase in mortality. Counties with economic and family distress, including rates of poverty, unemployment, disability, no college degree, public assistance, mental stress, divorce/separation, and single-parent families saw the highest rate of death (Monnat 2018).

However, the definition of rurality has not always been straightforward. The various definitions of rurality put forth by different government agencies often leads to confusion and uncertainty about how we define rural areas (United States Department of Agriculture Economic Research Service 2019). Rural definitions are given by three different government agencies: Office of Management and Budget (OMB), Census Bureau, and United States Department of Agriculture Economic Research Service (USDA-ERS), based on three major concepts: administrative, land-use, or economic area (Cromartie and Bucholtz 2008, United States Department of Agriculture Economic Research Service 2019).

The administrative concept adopted by the United States Department of Agriculture (USDA) defines urban as well as other municipal or jurisdiction areas (Cromartie and Bucholtz 2008). The land-use concept, used by the Census Bureau, identifies urban areas based on how densely settled the area (Cromartie and Bucholtz 2008).

The economic concept, used in most rural research applications, recognizes the influence of cities on labor, trade, and media markets that extend well beyond densely settled cores to include broader “commuting areas” (Cromartie and Bucholtz 2008). A clear-cut definition of rural is difficult as there are multiple dimensions to consider. Thus the choice of the definition

largely depends on the purpose of the study (Cromartie and Bucholtz 2008). Rurality is treated as a moderator variable, one that affects the strength of relationship between independent and dependent variables. Table 1 lists commonly used definitions for rurality.

Table 1 Commonly used definitions and operationalization of rurality

Defining agency	Classification base	Urban	Rural	Coding sequence
Office of Management and Budget (OMB), 2013 ^{a,b}	Social and economic integration with core, Economic: Labor-market, population nucleus	<i>Metropolitan (Metro)</i>	<i>Nonmetro counties</i> -Micropolitan (Micro), Noncore	1. <i>Metropolitan (Metro2013)</i> 0=No, 1=Yes
		a. Central counties with one or more urbanized areas; urbanized areas (described in the next section) are densely settled urban entities with 50,000 or more people.	a. Micropolitan (micro) areas, which are nonmetro labor-market areas centered on urban clusters of 10,000-49,999 persons and defined with the same criteria used to define metro areas.	
		b. Outlying counties that are economically tied to the core counties as measured by labor-force commuting. Outlying counties are included if 25 percent of workers living in the county commute to the central counties, or if 25 percent of the employment in the county consists of workers coming out from the central counties—the so-called "reverse" commuting pattern.	b. All remaining counties, often labeled "noncore" counties because they are not part of "core-based" metro or micro areas.	2. <i>Micropolitan (Micopolitan2013)</i> 0=No, 1=Yes, 3. <i>Noncore (Noncore2013)</i> 0=No, 1=Yes
United States department of Agriculture Economic Research Service (USDA-ERS) ^c , Rural-Urban Continuum Code (RUCC)-2013	Population size, degree of urbanization adjacent to metro (Economic and Social),	<i>Metropolitan Counties</i> 1. Counties in metro areas of 1 million population or more 2. Counties in metro areas of 250,000 to 1 million population 3. Counties in metro areas of fewer than 250,000 population	<i>Nonmetropolitan Counties</i> 4. Urban population of 20,000 or more, adjacent to a metro area 5. Urban population of 20,000 or more, not adjacent to a metro area 6. Urban population of 2,500 to 19,999, adjacent to a metro area 7. Urban population of 2,500 to 19,999, not adjacent to a metro area 8. Completely rural or less than 2,500 urban population, adjacent to a metro area 9. Completely rural or less than 2,500 urban population, not adjacent to a metro area	Urban/Metropolitan(1-3) Rural/Non-Metropolitan (4-9)

Census Bureau ^{a,d} Urban area census code (UACE)	Population size and density,	<i>Urbanized area</i> a. Urban nucleus of 50,000 or more people. They may or may not contain any individual cities of 50,000 or more. In general, they must have a core with a population density of 1,000 persons per square mile and may contain adjoining territory with at least 500 persons per square mile.	<i>Rural</i> Open countryside with population densities less than 500 people per square mile and places with fewer than 2,500 people.	<i>Urban</i> Counties with less than 50 percent of the population living in rural areas are classified as mostly urban
		<i>Urban Cluster</i> b. Urban clusters of at least 2,500 but less than 50,000 persons		<i>Rural</i> 50 to 99.9 percent are classified as mostly rural 100 percent rural are classified as completely rural.

a. Source: *Economic Research Service U.S. Department of Agriculture (USDA): What is Rural*, URL: <https://www.ers.usda.gov/topics/rural-economy-population/rural-classifications/what-is-rural/>

b. Source: *United States Census Bureau: About*, URL: <https://www.census.gov/programs-surveys/metro-micro/about.html>

c. Source: *Economic Research Service U.S. Department of Agriculture (USDA): Rural-Urban Continuum Codes*, URL: <https://www.ers.usda.gov/data-products/rural-urban-continuum-codes/>

d. Source: *United States Census Bureau: Urban and Rural*, URL: <https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html>

Livelihoods and DoD

Suicide rates differ by industry (Peterson et al. 2020). A CDC weekly report describes suicide rates as significantly higher in five major industry groups: 1) Mining, Quarrying, and Oil and Gas Extraction (males); 2) Construction (males); 3) Other Services (e.g., automotive repair) (males); 4) Agriculture, Forestry, Fishing, and Hunting (males); and 5) Transportation and Warehousing (males and females) (Peterson et al. 2020).

The occupation groups that showed significantly higher suicide rates compared to the general population of U.S. were 1) Construction and Extraction (males and females); 2) Installation, Maintenance, and Repair (males); 3) Arts, Design, Entertainment, Sports, and Media (males); 4) Transportation and Material Moving (males and females); 5) Protective Service (females); and 6) Healthcare Support (females) (Peterson et al. 2020).

In 2017, 95% of the 70,067 U.S. drug overdose deaths occurred among the working age population, persons aged 15-64 years (Hedegaard, Miniño and Warner 2018). For opioid deaths, construction workers and were found to have the highest proportional mortality rate (PMRs) for drug overdose death and for both heroin related and prescription opioid related overdose death (Morano, Steege and Luckhaupt 2018). Among most of them were male (96.7%), white (92.6%), and aged 45–54 years (30.4%) or 35–44 years (26.9%).

Similarly, extraction (e.g., mining, oil and gas extraction) and healthcare practitioner were the occupations that saw the highest deaths related to methadone, natural and semisynthetic opioids, and synthetic opioids other than methadone (Morano, Steege and Luckhaupt 2018). PMRs from drug overdose were significantly above 1.00 for the following six occupation groups: 1) construction (1.25); 2) extraction (1.16); 3) food preparation and serving (1.11); 4)

health care practitioners and technical (1.16); 5) health care support (1.18); and 6) personal care and service (1.10) (Morano, Steege and Luckhaupt 2018). An Ohio study found construction workers seven time more likely to die of overdose death in 2018 (Dissell 2019). Similarly, Massachusetts construction trade and extractor worker (CTEW) opioid related death rates were much higher than the average (Hawkins et al. 2019).

Construction trade and extractor workers (CTEW) face higher job injury and fatality rates requiring pain medication, including opioids but this cannot be fully elucidated (Ompad et al. 2019). Other reason suggested is the precarious nature of employment that is liable to discontinuities, suggested by the fact that higher drug use among those who were unemployed and had more employers (i.e., a proxy for temporary work or being laid off) (Ompad et al. 2019).

Drug-related mortality rates were also higher in counties with labor markets dependent on mining, but lower in counties dependent on government sector (Monnat 2018). The mining industry has experienced significant declines in recent decades, displacing many workers, but also adversely impacting secondary service industries in these areas (Bailey, Jensen and Ransom 2014, Nandi et al. 2006).

In a study of suicide trends (1999-2015) using a six-category urban-rural continuum, Kegler et al. (2017) found an urban-rural suicide gradient, with incrementally higher suicide rates at each rising level of rurality (Kegler, Stone and Holland 2017). In a review of the literature on alcohol use patterns among urban and rural residents, Dixon and Chartier (2016) found that studies had different conclusions about urban-rural disparities in alcohol use disorders depending on whether they used a dichotomous vs. more detailed rural-urban classification (Dixon and Chartier 2016).

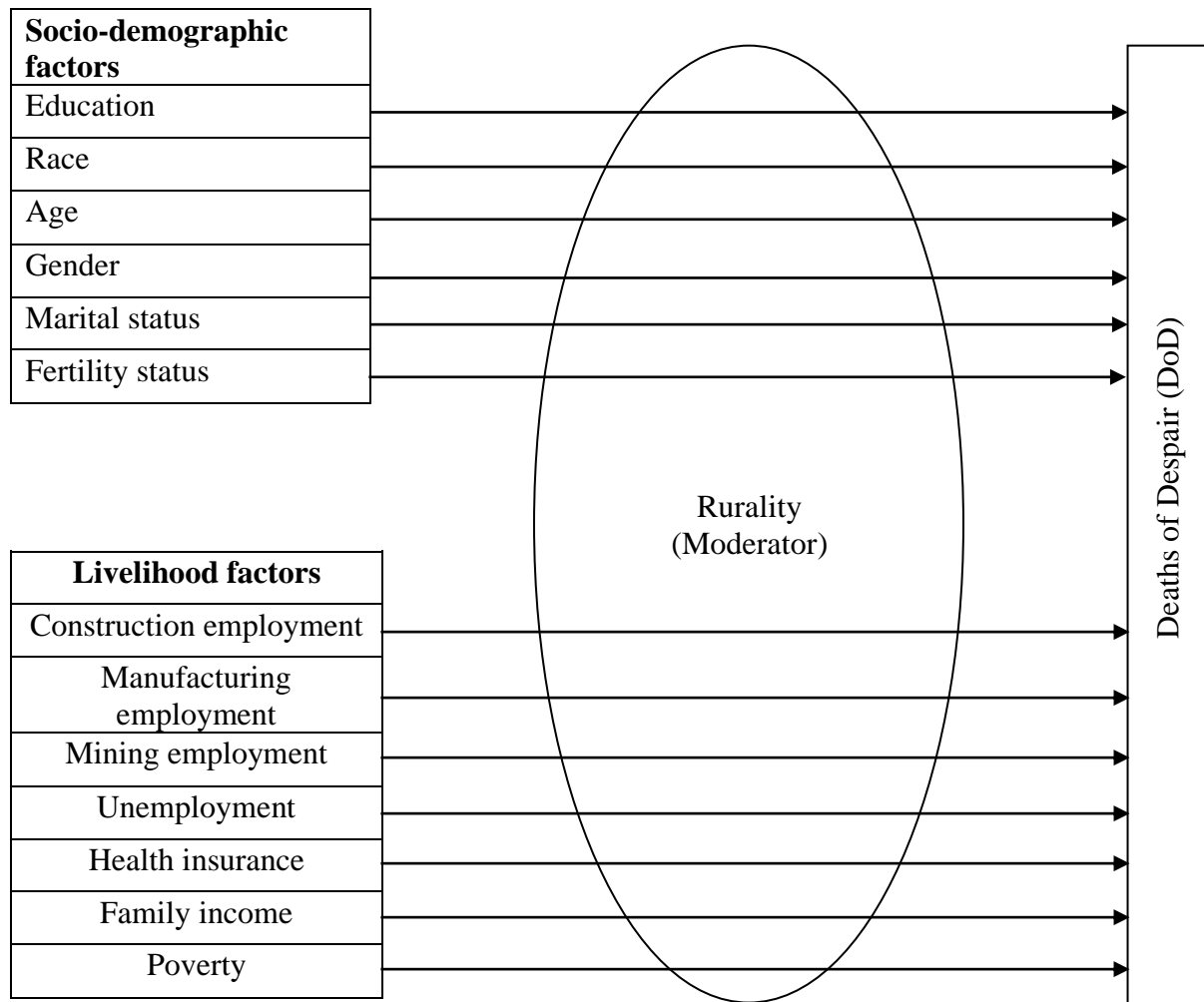


Figure 2 Conceptual framework for factors affecting DoD

2.4 Hypotheses

Based on the conceptual framework (Figure 2) and previous studies, this study proposes several hypotheses.

Education: Previous studies have highlighted that the risk of dying due to despair had risen markedly for those individuals who did not hold a four- year college degree (Case and Deaton 2017, Case and Deaton 2020). Thus based on previous literature I hypothesize that:

H1: DoD rates are negatively related to median education level.

Race: For whites between the ages of 45 and 54, deaths of despair tripled from 1990 to 2017 (Case and Deaton 2020, Stein et al. 2017). Thus, I hypothesize that,

H2: DoD rates are higher in counties where there are predominantly white non-Hispanic population.

Age: Mortality of middle-aged (45-54 year) workers was higher as compared to others (Case and Deaton 2015, Case and Deaton 2017). Thus, I hypothesize that,

H3: DoD rates are higher in counties with larger number of working-class people (25-64) compared to other.

Gender: Males were, twice as likely, as compared to females (Bohnert and Ilgen 2019, Case and Deaton 2020). Thus I hypothesize that,

H4: DoD rates are higher in counties with higher male to female ratio.

Marital status: Marriage has shown to have a preservative effect on suicide (Durkheim 2005) Thus I hypothesis that

H5: Counties with higher rate of married person will have the lower DoD rate as compared to those counties where there are large proportion of unmarried people of age greater than 16.

Fertility: Suicide has been suggested to decrease with the increase in the family density family density_because of the collective life (Durkheim 2005). Thus, I hypothesis that

H6: Counties having greater proportions of families with children have lower DoD rates compared to those with fewer children.

Source of livelihood: Construction, manufacturing and mining industry has seen significantly higher suicide rates (Dissell 2019, Morano, Steege and Luckhaupt 2018, Peterson et al. 2020). Thus, I hypothesize that,

H7a: Counties described as construction will see higher rate of DoD.

H7b: Counties described as manufacturing will see higher rate of DoD.

H7c: Counties described as mining will see higher rate of DoD.

Unemployment: Unemployment has been associated as one of the potential causes of despair among rural population (Betz and Jones 2018, Monnat 2018, Strumpf et al. 2017). There is variation in the definition of rurality (Rural Health Information Hub 2019). Thus, I hypothesize that,

H8: Counties which have larger changes in unemployment rates will see the highest rate of age adjusted changes in DoD.

Health insurance: Naloxone, the immediate treatment for opioid overdose, is expensive and might not be covered by all insurance types resulting in differential overdose death among different insurance types (Goldman-Mellor and Margerison 2019). Thus, I hypothesize that

H9: Counties with higher percentage of insured population will have lower DoD rates.

Family income: With decline in income there is a reduced prospect of marriage and prospect of having children leading to higher drug overdose deaths (Case and Deaton 2017, Sherman 2009). Thus, I hypothesize that,

H10: Counties with lower median family income will have higher DoD rates.

Poverty: Counties with economic and family distress, including rates of poverty, are expected to the highest rate of DoD (Monnat 2018). Thus, I hypothesize that,

H11: Counties with higher poverty rate will have higher DoD rates.

Chapter 3 Method

This study uses data from multiple sources that profile different aspects of U.S. counties or county equivalents (e.g., parishes, boroughs). This makes the county the unit of analysis. The analysis examines 3,149 U.S. counties, including those from Alaska.

3.1 Data Description

This research used multiple data sources profiling aspects of U.S. counties.

Dependent Variable

Drug poisoning mortality. Data on drug poisoning mortality, an indicator of Deaths of Despair, is obtained from National Center for Health Statistics (NCHS) - Drug Poisoning Mortality by County: United States. This dataset describes the estimated drug poisoning deaths, at the county level by selected demographic characteristics and includes age-adjusted death rates for drug poisoning from 1999 to 2016 (Centers for Disease Control and Prevention 2020). County level data was selected for higher level of accuracy.

Age-adjusted death rates (deaths per 100,000 U.S. standard population for 2000) are calculated using the direct method (Centers for Disease Control and Prevention 2020). Populations used for computing death rates for 2011–2016 were postcensal estimates based on the 2010 U.S. census. Rates for census years are based on populations enumerated in the corresponding censuses. Rates for nonsenses years before 2010 were revised using updated intercensal population estimates and may differ from rates previously published. The data used for this analysis were the difference in the drug poisoning mortality by county in 2016 to that for 2007. Median value for the range in original data were obtained for DoD. For observations <2

median value was calculated using the range 0 to 2 and for 30+ median value was calculated using 30 to 45.

Independent Variable

Unemployment and other control variables. Data on unemployment and other additional variables were drawn from datasets maintained by the United States Department of Agriculture-Economic Research Service (USDA-ERS) Atlas of Rural and Small-Town America. The excel file contain information related to the people, jobs, income, veterans, and county Classifications. Each tab includes the county FIPS code as the first column (Economic Research Service U.S. Department of Agriculture 2020b). Information related to the *unemployment status*, *poverty status*, *population of each county*, *median household income*, and *education level* available as of 2018 was extracted. Similarly, *median family income* was obtained from 2014—2018 American Community Survey (ACS) 5-Year Data (United states Census Bureau 2020a). Median family income was log transformed to ensure the normality of the distribution as well as to reduce the scale of the observation during the regression analysis (Benoit 2011, Manning and Mullahy 2001).

Rurality as context. Rurality is treated as a moderator variable, one that affects the strength of relationship between independent and dependent variables. Five different definitions of rurality were used for the analysis to categorize U.S. counties (Table 2).

- 1) The Office of Management and Budget (OMB) definition sorts all U.S. counties into metropolitan, and nonmetro categories (United states Census Bureau 2020b).
- 2) The United States Department of Agriculture Economic Research Service (USDA-ERS) defined a Rural-Urban Continuum Code (RUCC)-2013 that divides U.S. counties into nine categories. For this analysis, the nine categories were grouped into

three sets of counties: large metropolitan (code range 1-3); smaller metropolitan (code range 4-6); and the most rural subset (code range 7-9). Treating each classification of rurality as a contextual factor, we examine the durability of relationship between unemployment and the DoD (Economic Research Service U.S. Department of Agriculture 2020a).

- 3) The U.S. Census Bureau defines the rural population of a county as people who reside outside a place of 2,500 or people (incorporated or census-defined). Thus the counties was thus divided into three segments based on percentage of people residing in the rural areas (United states Census Bureau 2019).
 - a. Tertials (Q1, Q2 and Q3) of U.S. counties based on percent rural.
 - b. Quartiles (Q1, Q2, Q3, and Q4) of U.S. counties based on percent rural.
 - c. Quintiles (Q1, Q2, Q3, Q4 and Q5) of U.S. counties based on percent rural.

Definitions from the OMB and U.S. census Bureau were chosen as previous research suggests that they were the most commonly used classification system (Coburn et al. 2007).

Table 2 Five definitions of rurality, U.S. counties

Variable	Nominal definition	Source	Year	Cases	Min	Max	Missing	Total
<i>OMB metropolitan, micropolitan, and nonmetro categories 1-3</i>		USDA-ERS	2013		0=No	1=Yes		
Metropolitan	a. Central counties with one or more urbanized areas; urbanized areas (described in the next section) are densely settled urban entities with 50,000 or more people. b. Outlying counties that are economically tied to the core counties as measured by labor-force commuting. Outlying counties are included if 25 percent of workers living in the county commute to the central counties, or if 25 percent of the employment in the county consists of workers coming out from the central counties—the so-called "reverse" commuting pattern	USDA-ERS	2013	1167	0=No	1=Yes		
Micropolitan	Micropolitan (micro) areas, which are nonmetro labor-market areas centered on urban clusters of 10,000-49,999 persons and defined with the same criteria used to define metro areas.	USDA-ERS	2013	1335	0=No	1=Yes		
Noncore	All remaining counties, often labeled "noncore" counties because they are not part of "core-based" metro or micro areas.	USDA-ERS	2013	641	0=No	1=Yes		
Total				3143			6	3149
<i>Rural-Urban Continuum Code (RUCC) 1-9</i>		USDA-ERS	2013		0=No	1=Yes		
Metropolitan	1. Counties in metro areas of 1 million population or more 2. Counties in metro areas of 250,000 to 1 million population 3. Counties in metro areas of fewer than 250,000 population	USDA-ERS	2013	1=432 2=379 3=356	0=No	1=Yes		

Small metro	4. Urban population of 20,000 or more, adjacent to a metro area 5. Urban population of 20,000 or more, not adjacent to a metro area 6. Urban population of 2,500 to 19,999, adjacent to a metro area 7. Urban population of 2,500 to 19,999, not adjacent to a	USDA-ERS	2013	4=214 5=92 6=593 7=433 8=220 9=424	0=No 1=Yes			
Rural	7. Urban population of 2,500 to 19,999, not adjacent to a metro area 8. Completely rural or less than 2,500 urban population, adjacent to a metro area 9. Completely rural or less than 2,500 urban population, not adjacent to a metro area	USDA-ERS	2013	4=214 5=92 6=593 7=433 8=220 9=424	0=No 1=Yes			
Total				3142			7	3149
Rural tertials: Percent rural in three categories 1-3	1=Percentage rural population 0 to <=33.33 2=Percentage rural population <33.33 to <= 66.66 3=Percentage rural population <66.66 to <= 100	US census	2010	1=786 2=1029 3=1327	N/A N/A			
Total				3142			7	3149
Rural quartiles: Percent rural in four categories 1-4	1=Percentage rural population 0 to <=25 2=Percentage rural population <25 to <= 50 3=Percentage rural population <50 to <= 75 4=Percentage rural population <75 to <= 100	US census	2010	1=571 2=687 3=822 4=1062	N/A N/A			
Total				3142			7	3149
Rural quintiles: Percent rural in five categories 1-5	1=Percentage rural population 0 to <=20 2=Percentage rural population <20 to <= 40 3=Percentage rural population <40 to <= 60 4=Percentage rural population <60 to <= 80 5=Percentage rural population <80 to <= 100	US census	2010	1=454 2=505 3=623 4=626 5=934	N/A N/A			
Total				3142			7	3149

ACS: American Community Survey (ACS) 2014-2018), NCHS: National Center for Health Statistics (Updated June 5, 2020), USDA ERS: Atlas of Rural and Small Town America (21)-United States Department of Agriculture Economic Research Service

3.2 Data Analysis

The five categorizations of U.S. Counties inevitably coincide and overlap in multiple ways. Nonetheless, each represents a distinct approach to categorizing rurality in the U.S. The objective of the analysis is to determine the durability of established relationships across various groupings of counties. Thus, the approach encompasses multiple tests of a core set of hypotheses across various contexts of rurality.

Ordinary least squares regression was used to estimate the extent to which decrease in employment were correlated with amounts of drug death mortality conditioned on other mediating variables such as rurality and socioeconomic variables. However, a preliminary descriptive analysis will be conducted to acquire some basic understandings and distribution of different independent variables and the dependent variables. Pearson correlations examine the association between the study variables. Regression analysis will be used to assess the impact of the independent variables, their consistency across definitions of rurality, and their overall ability to explain DoD. The analysis examines both DoD in 2016, and the change in DoD between 2007 and 2016.

3.3 Regression Model

Regression analysis, ordinary least square regression, will be conducted to examine opioid deaths as a measure of despair (DoD). Durability of such relationships will be examined across five different definition of rurality. The regression model is thus given as:

Opioid related death (DoD) = $\beta_0 + \beta_1 \text{education} < \text{high school} + \beta_2 \text{percent white non-Hispanic} + \beta_3 \text{median age} + \beta_4 \text{gender ratio} + \beta_5 \text{percent married} + \beta_6 \text{fertility rate} + \beta_7 \text{percent construction employment} + \beta_8 \text{percent manufacturing employment} + \beta_9 \text{percent mining}$

employment+ β_{10} unemployment rate (2016) + β_{11} percent health insurance + β_{12} log (Median family Income) + β_{13} percentage poverty.....(i)

Opioid related death change (DoD) (2007-2016) = β_0 + β_1 education<high school+ β_2 percent white non-Hispanic+ β_3 median age+ β_4 gender ratio + β_5 percent married+ β_6 fertility rate+ β_7 percent construction employment+ β_8 percent manufacturing employment + β_9 percent mining employment+ β_{10} unemployment rate change (2007-2016) + β_{11} percent health insurance + β_{12} log (Median family Income) + β_{13} percentage poverty.....(ii)

Where β_0 =intercept of the regression model, $\beta_1, \beta_2, \dots, \beta_{13}$ are the slope of the regression model that will provide an estimate of how much the DoD change with the change in one unit of independent variable.

Chapter 4 Results and Findings

In this chapter hypotheses are tested, and results are discussed. First, descriptive analyses provide a general understanding of dependent and independent variables as well as the various definition of rurality. Second, correlations among explanatory variables are examined within county subsets of rurality. In the last section we perform two regression analysis to test the hypothesized relationships between unemployment and DoD using various definitions of rurality as the context.

4.1 Descriptive Analysis

Table 3 provides descriptions of key dependent and independent variables. The relationship between the DoD and unemployment might be affected by education, race, age, gender, marital status, fertility, livelihood, insurance status, median family income, and poverty and thus these serve as control variables. Rurality was used as the context variable is presented in Table 2. Definitions of rurality were based on OMB, USDA-ERS and U.S. Census Bureau.

From Table 3, we can see that the average percentage of drug poisoning mortality rate in 2016 was 16.7. This drug poisoning mortality percentage is an increase of 8.3 percent from the year 2007. As a source of livelihood, 7.3 percent of people were employed in the construction industry, 12.3 percentage were employed in the manufacturing industry, and 1.6 percent were employed in the mining industry. The percentage unemployment change was relatively low with an increase of 0.36 percentage in unemployment from 2007 to 2016. On average the median family income during 2014-2018 among the counties was \$64,061 (in 2018 dollars).

Table 3 Variables used in analysis, characteristics of U.S. counties

Variable	Nominal definition	Source	Year	Min	Max	Mean	Cases	Missing	Total
<i>Dependent variable</i>									
Change in DoD:	Change in drug poisoning mortality rate (Percent)	NCHS	2007-2016	0	28.5	8.28	3136	13	3149
DoD:	Drug poisoning mortality rate (Percent)	NCHS	2016	1	38	16.65	3136	13	3149
<i>Independent variables</i>									
Education:	Percent of persons with no high school diploma or GED, adults 25 and over, 2014-18	USDA-ERS	2014-2018	1.18	66.34	13.41	3142	7	3149
Race:	Percent Non-Hispanic White	USDA-ERS	2010	2.67	99.16	78.3	3142	7	3149
Age:	Median Age of residents (Years)	ACS	2014-2018	21.7	67	41.3	3142	7	3149
Gender:	Sex ratio (male per 100 females)	ACS	2014-2018	70.6	376.1	100.9	3142	7	3149
Marital status:	Percent Estimate Married-couple family	ACS	2014-2018	17	84	50.8	3142	7	3149
Fertility: Fertility rate	Number of women 15 to 50 years old who had a birth in the past 12 months: Per 1,000 women 15 to 50 years old	ACS	2014-2018	0	1000	58.11	3142	7	3149
<i>Source of livelihood: Percent employed in extractive industry</i>									
Construction	Percent of the civilian labor force 16 and over employed in construction, 2014-18	USDA-ERS	2014-2018	0	25.53	7.33	3141	8	3149
Manufacturing	Percent of the civilian labor force 16 and over employed in manufacturing, 2014-18	USDA-ERS	2014-2018	0	51.73	12.29	3141	8	3149
Mining	Percent of the civilian labor force 16 and over employed in mining, quarrying, oil and gas extraction, 2014-18	USDA-ERS	2014-2018	0	44.04	1.56	3141	8	3149
Unemployment: Unemployment rate,	Percent employment change, 2007-2016	USDA-ERS	2007-2016	-13.6	12.2	0.36	3149	0	3149

year									
Insurance Status	Percentage of insured population 2018	ACS	2018	54.4	98.3	89.9	3142	7	3149
Median Family Income (MFI)	Median family income adjusted to 2018 dollars	ACS	2018	21816	178542	64061	3141	8	3149
Poverty rate	Poverty rate all ages, 2018	USDA-ERS	2018	2.6	54	15.16	3141	8	3149
Total							3142	7	3149

ACS: American Community Survey (ACS) 2014-2018), NCHS: National Center for Health Statistics (Updated June 5, 2020), USDA ERS: Atlas of Rural and Small Town America (21)-United States Department of Agriculture Economic Research Service

4.2 Correlation

Correlations summarize the linear association, and the strength of linear association between two variables. Knowledge regarding such linear relationship is helpful in estimating the presence of multicollinearity, as well as the strength of linear relationship between two independent variables. Multicollinearity should be addressed in the regression analysis as presence of multicollinearity will reduce the reliability of the parameter estimates (Alin 2010, Mansfield and Helms 1982).

Table 4 present the correlations between DoD (2016) and the independent variable included. Overall correlation between the DoD and the independent variables were low. Rural counties showed higher degree of correlated between unemployment and DoD. The highest degree of correlation (0.417) was observed between unemployment rate for 2016 and the rural quintiles category 5 (percentage rural population $80 < \text{to} \leq 100$). This correlation was significant at 0.01 level. In other words, there is moderate positive relationship in rural quintile's category 5, DoD.

Similarly, Table 5 present s the correlation between change in DoD from 2007 to 2016 and the independents variables included in the analysis. Similar to the previous result, overall correlation between the DoD and the independent variables were low. The highest degree of correlation (0.335) was observed between median age for a county and DoD in the rural quintile's category 2 (percentage rural population $20 < \text{to} \leq 40$). This correlation was significant at 0.01 level. In other words, there is a weak positive relationship between median age for a county and DoD.

Table 4 Correlations between DoD and independent variables under five definitions of rurality, U.S. counties

Independent variables	OMB metropolitan, micropolitan, and nonmetro categories 1-3			USDA Rural-Urban Continuum Code (RUCC) 1-9			Rural tertials Percent rural in three categories			Rural quartiles: Percent rural in four categories				Rural quintiles: Percent rural in five categories				
	Metro	Micro	Noncore	RUC C1-3	RUC C4-6	RUC C7-9	3Q1	3Q2	3Q3	4Q1	4Q2	4Q3	4Q4	5Q1	5Q2	5Q3	5Q4	5Q5
Education < high school	0.099**	0.094*	0.174**	0.099**	0.067*	0.204**	-0.020	0.070*	0.238**	-0.045	0.008	0.182**	0.240**	-0.028	0.007	0.046	0.242**	0.232**
Percent white non-Hispanic	0.150**	0.093*	0.079**	0.150**	0.137**	0.049	0.119**	0.071*	0.120**	0.164**	0.054	0.121**	0.112**	0.179**	0.105*	0.058	0.163**	0.098**
Median age	0.228**	0.252**	0.087**	0.228**	0.278**	0.070*	0.340**	0.268**	0.034	0.286**	0.373**	0.175**	0.038	0.295**	0.393**	0.303**	0.086*	0.045
Gender ratio	-0.083**	-0.061	-0.032	-0.083**	-0.048	-0.031	-0.132**	-0.020	-0.037	-0.165**	-0.037	0.000	-0.046	-0.145**	-0.070	0.002	-0.004	-0.055
Percent married	-0.175**	-0.103**	-0.082**	-0.175**	-0.008	-0.130**	-0.230**	-0.078*	-0.087**	-0.236**	-0.117**	-0.042	-0.107**	-0.247**	-0.124**	-0.091*	-0.015	-0.114**
Fertility rate	-0.034	-0.143**	-0.131**	-0.034	-0.109**	-0.142**	-0.065	-0.083**	-0.136**	-0.077	-0.031	-0.101**	-0.145**	-0.077	-0.043	-0.057	-0.097*	-0.149**
Percent construction employment	0.047	0.040	0.115**	0.047	0.130**	0.087**	0.027	0.095**	0.094**	0.018	0.145**	0.039	0.103**	0.052	0.105*	0.115**	0.040	0.099**
Percent manufacturing employment	-0.016	-0.111**	-0.04	-0.016	-0.164**	0.005	-0.096**	-0.163**	0.033	-0.056	-0.180**	-0.160**	0.082**	-0.057	-0.152**	-0.176**	-0.143**	0.093**
Percent mining employment	0.067*	0.100**	0.085**	0.067*	0.112**	0.079**	-0.007	0.150**	0.080**	0.002	0.073	0.220**	0.053	-0.008	0.036	0.194**	0.193**	0.050
Unemployment rate (2016)	0.226**	0.314**	0.359**	0.226**	0.232**	0.403**	0.165**	0.259**	0.399**	0.105*	0.243**	0.325**	0.406**	0.103*	0.234**	0.269**	0.323**	0.417**
Percent health insurance	-0.052	-0.003	-0.053	-0.052	-0.035	-0.047	0.010	-0.059	-0.049	0.057	-0.047	-0.107**	-0.04	0.044	-0.047	-0.051	-0.119**	-0.027
Median family income (log)	-0.244**	-0.231**	-0.326**	-0.244**	-0.189**	-0.365**	-0.190**	-0.214**	-0.342**	-0.190**	-0.169**	-0.305**	-0.350**	-0.216**	-0.181**	-0.202**	-0.327**	-0.357**
Percent poverty	0.174**	0.186**	0.269**	0.174**	0.115**	0.328**	0.108**	0.150**	0.305**	0.092*	0.099**	0.233**	0.316**	0.115*	0.094*	0.147**	0.262**	0.317**
(Number)	1158	639	1327	1158	897	1069	778	1027	1317	563	685	821	1052	448	502	621	624	925

** Correlation is significant at the 0.01 level (2-tailed),

* Correlation is significant at the 0.05 level (2-tailed)

Table 5 Correlations between changes in DoD and independent variables under five definitions of rurality, U.S. counties

Independent variables	OMB metropolitan, micropolitan, and nonmetro categories 1-3			USDA Rural-Urban Continuum Code (RUCC) 1-9			Rural tertials Percent rural in three categories			Rural quartiles: Percent rural in four categories				Rural quintiles: Percent rural in five categories				
	Metro	Micro	Noncore	RUCC 1-3	RUCC 4-6	RUCC 7-9	3Q1	3Q2	3Q3	4Q1	4Q2	4Q3	4Q4	5Q1	5Q2	5Q3	5Q4	5Q5
Education < high school	0.105**	0.079*	0.049	0.105*	0.096*	0.072*	0.047	0.070*	0.081**	0.041	0.059	0.116**	0.075*	0.025	0.094*	0.035	0.174**	0.068*
Percent white non-Hispanic	0.187**	0.083*	0.032	0.187*	0.110*	-0.004	0.092*	0.044	0.052	0.117**	0.037	0.049	0.051	0.154**	0.025	0.064	0.080*	0.028
Median age	0.301**	0.234**	0.099**	0.301*	0.233**	0.105**	0.286**	0.256**	0.077**	0.240**	0.333**	0.171**	0.066*	0.255**	0.335**	0.298**	0.077	0.062
Gender ratio	-0.001	0.007	0.018	-0.001	0.029	0.009	-0.022	0.087**	0.009	-0.073	0.090*	.071*	-0.002	-0.081	0.061	0.125**	0.028	-0.013
Percent married	-0.088**	0.006	-0.042	-0.088**	0.063	-0.078*	-0.163**	-0.044	-0.066*	-0.172**	-0.069	-0.029	-0.089**	-0.181**	-0.100*	-0.040	0.001	-0.103**
Fertility rate	0.003	-0.101*	-0.094**	0.003	-0.032	-0.116**	0.006	0.001	-0.094**	-0.023	0.048	-0.005	-0.111**	-0.038	0.032	0.027	-0.007	-0.119**
Percent construction employment	0.131**	0.092*	0.110**	0.131**	0.137**	0.114**	0.064	0.093**	0.085**	0.063	0.138**	0.027	0.087**	0.055	0.144**	0.104**	0.027	0.089**
Percent manufacturing employment	0.008	-0.092*	-0.106**	0.008	-0.157**	-0.034	-0.137**	-0.199**	-0.037	-0.084*	-0.233**	-0.182**	0.010	-0.070	-0.228**	-0.215**	-0.147**	0.026
Percent mining employment	0.066*	0.100*	0.073**	0.066**	0.151**	0.040	0.129**	0.186**	0.035	0.143**	0.137**	0.229**	0.006	0.117*	0.146**	0.219**	0.187**	-0.005
Unemployment rate change	0.092**	0.108**	0.113**	0.092**	0.165**	0.087**	0.084*	0.173**	0.095**	0.063	0.140**	0.193**	0.081**	0.052	0.097*	0.218**	0.166**	0.074*
Percent health insurance	-0.078**	-0.021	-0.112**	-0.078**	-0.074**	-0.118**	-0.087*	-0.102**	-0.110**	-0.050	-0.122**	-0.153**	-0.093**	-0.041	-0.155**	-0.073	-0.180**	-0.092**
Median family income (log)	0.258**	0.180**	0.193**	0.258**	0.171**	0.231**	0.218**	0.211**	0.207**	0.212**	0.198**	0.262**	0.206**	0.215**	0.234**	0.191**	0.279**	0.208**
Percent poverty	0.161**	0.128**	0.132**	0.161**	0.078**	0.186**	0.120**	0.140**	0.170**	0.109**	0.103**	0.200**	0.172**	0.102*	0.148**	0.114**	0.222**	0.170**
(Number)	1158	639	1327	1158	897	1069	778	1027	1317	563	685	821	1052	448	502	621	624	925

** Correlation is significant at the 0.01 level (2-tailed),

* Correlation is significant at the 0.05 level (2-tailed)

From this analysis, we can say that the regression analysis will produce reliable estimates. The independent or predictor variables in this study were relatively uncorrelated from each other.

4.3 Regression

Table 6 presents the unstandardized beta coefficients for the regression analysis between the DoD for the year 2016 under five definitions of rurality for U.S. counties. Significant results were shown in bold. In this analysis, the main interest variable is the relationship between unemployment and source of livelihood with DoD. Results showed that keeping all other variable constant unemployment rate was significant factors predicting DoD. As expected, positive sign of the beta coefficient suggests that as the unemployment rate increases rate of opioid related death increase. However, unemployment rate for urban counties such as category 1 of rural quartiles (percentage rural population 0 to ≤ 25) and rural quintiles (1=percentage rural population 0 to ≤ 20) were not associated with the DoD.

Similarly, for source of livelihood, study result showed a statistically significant relationship between percentage construction employment and DoD. In other words, keeping all other variables constant, rural counties such as noncore, RUCC7-9, rural quartiles category 4 (percentage rural population $75 <$ to ≤ 100) and rural quantiles category 5 (percentage rural population $80 <$ to ≤ 100), showed a significant relationship with DoD. Positive sign of beta coefficient suggests that, as the percentage construction employment increase the opioid related death increase. Additionally, a statistically significant and positive relationship was observed among percentage of people employed in mining in rural counties with DoD.

Interestingly, as the percent of manufacturing employment increases the rate of opioid overdose related deaths decreased for relative urban counties. This finding might suggest that

increase in manufacturing jobs that is physically less intensive, and perhaps less cyclical than construction and mining, is able to achieve economic stability with employment in manufacturing section that might reduce DoD.

For other variables, in general, higher percentage of white non-Hispanic, older age, and poverty rate in a county significantly increase DoD. On the other hand, increase in the education level, marital rate, fertility rate, having insurance and higher level of income for a country would significantly decrease DoD. Gender ratio (number of males for 100 females) were found to be statistically non-significant across different definition of rurality.

As in Table 6, Table 7 presents the unstandardized beta coefficient for the regression analysis between the change in DoD for the year 2007 and 2016 under five definitions of rurality for U.S. counties. Unlike previous findings, results showed that keeping all other variable constant change in unemployment rate from 2007 to 2016 was only statistically significant in predicting DoD for rural tertials category 2 (percentage rural population $33.33 < \text{to} \leq 66.66$), rural quartiles category 3 (percentage rural population $50 < \text{to} \leq 75$) and rural quintiles category 3 (Percentage rural population $40 < \text{to} \leq 60$).

For the source of livelihood, results were similar to previous finding. Construction, manufacturing, and mining was significantly associated with the DoD. However, increase in the percentage of construction and mining employment increased the change in DoD whereas increase in the manufacturing jobs decreased the change in DoD.

Table 6 Regression of DoD on selected independent variables under five definitions of rurality, U.S. counties

Independent variables	OMB metropolitan, micropolitan, and nonmetro categories 1-3			USDA Rural-Urban Continuum Code (RUCC) 1-9			Rural tertials: Percent rural in three categories 1-3			Rural quartiles: Percent rural in four categories 1-4				Rural quintiles: Percent rural in five categories 1-5				
	Metro	Micro	Noncore	RUCC1-3	RUCC4-6	RUCC7-9	3Q1	3Q2	3Q3	4Q1	4Q2	4Q3	4Q4	5Q1	5Q2	5Q3	5Q4	5Q5
(Constant)	55.493	83.303	112.403	55.493	73.844	112.561	95.911	82.790	57.635	119.104	72.059	96.767	56.302	118.080	79.630	72.593	87.899	64.340
Education < high school	0.172	0.201	-0.027	0.172	0.172	-0.023	0.045	-0.001	0.069	0.171	-0.081	0.084	0.047	0.201	-0.077	-0.022	0.263	0.010
Percent white non-Hispanic	0.176	0.174	0.163	0.176	0.169	0.162	0.090	0.141	0.202	0.106	0.100	0.189	0.188	0.123	0.140	0.120	0.219	0.178
Median age	0.225	0.322	0.084	0.225	0.345	0.058	0.447	0.355	0.070	0.342	0.457	0.277	0.081	0.380	0.458	0.443	0.162	0.091
Gender ratio	-0.054	-0.010	0.001	-0.054	-0.044	0.005	-0.037	-0.028	-0.004	-0.081	-0.005	-0.012	-0.011	-0.024	-0.027	0.006	-0.019	-0.016
Percent married	-0.314	-0.096	0.021	-0.314	-0.021	-0.002	-0.270	0.103	0.030	-0.287	-0.042	0.220	0.017	-0.297	-0.063	0.095	0.173	0.044
Fertility rate	0.022	0.044	-0.018	0.022	-0.025	-0.019	-0.010	0.025	0.017	-0.030	-0.004	0.025	0.016	-0.034	-0.001	0.019	0.021	0.016
Percent construction employment	-0.138	-0.154	0.234	-0.138	-0.041	0.217	0.051	0.189	0.220	0.201	0.264	0.067	0.245	0.274	0.236	0.214	-0.029	0.237
Percent manufacturing employment	-0.204	0.187	-0.039	-0.204	-0.206	-0.019	-0.240	0.157	0.007	-0.266	-0.168	-0.165	0.052	-0.299	-0.167	-0.132	-0.200	0.072
Percent mining employment	0.003	0.285	0.288	0.003	0.276	0.299	0.085	0.317	0.196	0.220	0.140	0.288	0.210	0.207	0.079	0.353	0.159	0.219
Unemployment rate (2016)	1.035	0.804	1.000	1.035	0.469	1.060	0.621	0.856	1.186	0.235	0.893	1.002	1.139	0.191	0.980	0.953	0.917	1.178
Percent health insurance	-0.233	-0.107	-0.151	-0.233	-0.102	-0.141	-0.019	-0.130	0.170	0.204	-0.145	0.162	0.155	0.261	-0.281	-0.080	-0.186	-0.152
Median family income (log)	-4.357	16.790	-23.043	-4.357	-15.243	-22.994	16.787	18.354	12.699	23.522	14.492	23.081	12.332	-25.917	13.394	18.400	19.672	14.266
Percent poverty	-0.166	0.020	0.217	-0.166	0.096	0.234	-0.231	0.157	0.332	-0.340	0.031	0.248	0.341	-0.317	0.027	0.143	0.176	0.357
R ²	0.222	0.283	0.276	0.222	0.272	0.296	0.269	0.260	0.318	0.270	0.264	0.355	0.310	0.304	0.296	0.273	0.371	0.313
Adjusted R ²	0.214	0.268	0.269	0.214	0.261	0.287	0.256	0.250	0.311	0.253	0.249	0.344	0.302	0.284	0.277	0.257	0.357	0.303
F-ratio	25.248	19.029	38.553	25.248	25.357	34.160	21.689	27.345	46.768	15.730	18.504	34.174	36.035	14.668	15.845	17.561	27.704	32.058
(Number)	1160	639	1327	1160	896	1070	780	1027	1319	565	685	821	1054	449	503	621	624	927

Coefficients in bold are at least 2x their standard errors.

Table 7 Regression of change in DoD on selected independent variables under five definitions of rurality, U.S. counties

Independent variables	OMB metropolitan, micropolitan, and nonmetro categories 1-3			USDA Rural-Urban Continuum Code (RUCC) 1-9			Rural tertials: Percent rural in three categories 1-3			Rural quartiles: Percent rural in four categories 1-4				Rural quintiles: Percent rural in five categories 1-5				
	Metro	Micro	Noncor e	RUCC1 -3	RUCC4 -6	RUCC7 -9	Q1	Q2	Q3	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q5
(Constant)	.089	6.404	6.498	6.089	5.107	7.743	1.253	2.512	8.242	2.800	1.733	3.916	6.259	6.744	0.003	5.486	3.636	1.129
Education < high school	.069	.038	0.085	.069	.062	0.104	.042	0.054	0.068	.092	0.011	0.096	0.074	.104	0.006	0.060	0.007	0.089
Percent white non-Hispanic	.067	.046	.046	.067	.057	.037	.039	.042	.062	.050	.039	.050	.062	.061	.051	.035	.065	.054
Median age	.178	.177	.083	.178	.153	.112	.218	.196	.094	.168	.235	.175	.078	.182	.235	.227	.128	.079
Gender ratio	0.001	.015	.017	0.001	.003	.016	.002	.021	.014	0.031	.029	.019	.010	0.007	.003	.045	.004	.008
Percent married	0.088	.029	0.008	0.088	.020	.008	0.088	.052	0.003	0.100	0.016	.098	0.023	0.105	0.005	.044	.092	0.021
Fertility rate	.015	0.018	0.009	.015	0.004	0.010	0.001	0.002	0.007	0.012	.003	.001	0.008	0.017	.004	0.001	.002	0.008
Percent construction employment	.004	.001	.112	.004	0.032	.150	0.042	.038	.126	.074	.015	.001	.138	.025	.090	.039	0.038	.150
Percent manufacturing employment	0.085	0.047	0.026	0.085	0.082	.017	0.136	0.071	.009	0.134	0.100	0.055	.030	0.142	0.109	0.063	0.067	.043
Percent mining employment	0.016	.128	.145	0.016	.131	.152	.143	.152	.093	.218	.089	.169	.086	.189	.112	.138	.137	.087
Unemployment rate change	.104	.146	.074	.104	.169	.035	0.046	.191	.069	0.160	.090	.197	.051	0.102	0.123	.369	.071	.051
Percent health insurance	0.077	0.033	0.142	0.077	0.040	0.161	0.014	0.082	0.156	.065	0.092	0.123	0.145	.060	0.118	0.032	0.145	0.145
Median family income (log)	4.119	8.382	15.318	4.119	11.577	13.687	9.743	13.167	10.013	10.565	10.235	15.334	9.356	11.773	9.374	15.218	12.402	10.197
Percent poverty	.024	.073	.029	.024	0.009	.101	0.079	.057	.129	0.111	0.012	.119	.132	0.124	.040	.023	.108	.126
R ²	.210	.182	.125	.210	.212	.134	.242	.237	.119	.242	.261	.260	.109	.264	.296	.272	.238	.105
Adjusted R ²	.202	.165	.116	.202	.200	.123	.229	.228	.110	.225	.247	.248	.098	.242	.277	.256	.221	.092
F-ratio	3.480	0.705	4.411	3.480	8.262	2.580	8.741	4.285	3.509	3.541	8.244	1.822	.807	2.012	5.817	7.470	4.644	.197
(Number)	158	39	327	158	97	069	78	027	317	63	85	21	052	48	02	21	24	25

Coefficients in bold are at least 2x their standard errors.

For other variables in general, higher percentage of white non-Hispanic, older age, and poverty rate in a county would significantly increase the DoD. On the other hand, increase in the education level, marital rate, fertility rate, having insurance and higher level of income for a country would significantly decrease the DoD. In contrary to the previous findings, gender ratio (number of males for 100 females) was found to be statistically significant among rural counties.

4.4 Hypothesis

Table 8 presents the results for the hypothesis tests. There was strong support for most of the hypotheses, as they were statistically significant. However, the hypothesis that manufacturing will see higher rate of DoD was not substantiated by the findings. This might be because physical injury among manufacturing workers might be low thus requiring less opioid prescription drugs as compared to construction and mining industry. On the other hand, manufacturing industry might provide stable economic benefit as compared two other industry type.

Table 8 Summary of empirical findings

	Hypothesis	Evidence of support	Consistency across definition
H1:	DoD rates are negatively related to median education level.	Mild	Lower Consistency
H2:	DoD rates are higher in counties where there are predominantly white non-Hispanic population.	Strong	Higher Consistency
H3:	DoD rates are higher in counties with larger number of working-class people (25-64) compared to other.	Strong	Higher Consistency
H4:	DoD rates are higher in counties with higher male to female ratio.	Weak	Higher Consistency
H5:	Counties with higher rate of married person will have the lower DoD as compared to those counties where there are large number of unmarried people of age greater than 16.	Strong	Higher Consistency
H6:	Counties having greater number of family with children has lower DoD compared to those with no children.	Strong	Higher Consistency

H7a:	Counties described as construction will see higher number of DoD.	Strong	Higher Consistency
H7b:	Counties described as manufacturing will see higher number of DoD.	Opposite	Higher Consistency
H7c:	Counties described as mining will see higher number of DoD.	Strong	Higher Consistency
H8:	Counties which have largest change in unemployment will see the highest number of age adjusted change in DoD.	Weak	Higher Consistency
H9:	Counties with higher percentage of insured population will have lower DoD.	Strong	Medium consistency
H10:	Counties with low median family income will have higher DoD.	Strong	Medium Consistency
H11:	Counties with higher poverty rate will have DoD.	Strong	Lower consistency

4.5 Durability of the Relationship

Durability of the relationship was examined by observing consistency in the relationship between unemployment and livelihood with DoD across the different definition of rurality. The results suggest that, despite slight variations, the relationship between the unemployment and DoD was relative stable across different definition of rurality. Similarly, the relationship between livelihood (construction employment, manufacturing employment and the mining employment) and DoD also showed consistent results.

Chapter 5 Implications and Conclusion

Varying definition of rurality pose several administrative and policy challenges in terms of defining rural population, conducting economic analysis, identification of socioeconomically underprivileged population, and resource allocation. Thus, this empirical study seeks to clarify the moderating role of different definitions of rurality by looking at the relationship between opioid related overdose death and employment decline. Relationship between change in opioid related overdose death and employment decline were also estimated. Correlation and multiple linear regression analysis with education, race, age, gender, marital status, fertility, health insurance, family income, and poverty, as an independent variable informs the findings.

5.1 Major Findings

Our analysis suggests that, despite varying definition of rurality, the relationship between the unemployment and opioid related death remained relatively stable. In general, opioid related death increased with the increase in unemployment rate for rural counties. However, this relationship was weak among urban counties, indicating that unemployment has a greater impact on DoD among rural communities.

Similarly, the relationship between the livelihood (construction employment, manufacturing employment and the mining employment) and opioid related death were consistent across the varying definition of rurality. This study showed that county with higher percentage of construction and mining employment saw higher opioid related death among rural counties. However, as the percent of manufacturing employment increases the rate of opioid overdose related deaths decreased among urban counties. This relationship was stable across the varying definition of rurality.

For other control variables, results suggested that, counties with higher percentage of white non-Hispanic, older age, and poverty rate saw higher opioid related deaths. On the other hand, counties with higher education level, marital rate, fertility rate, having insurance and higher level of income saw a decrease in opioid related death. Surprising, results showed that opioid related death was not associated with higher percentage of males. In general, this relation was durable across varying definition of rurality.

5.2 Theoretical Implications

Findings from this study are more in line with the Durkheim theory on suicide which suggest that the tendency to suicide is neither defined by the organic-psychic constitution of individuals nor the nature of physical environment but depends upon the social cause and should be a collective phenomenon (Durkheim 2005). In line with the Durkheim perspective the results suggests that suicide is the consequence of social situations such as unemployment gender, education, income, marriage, fertility etc. In different words, we observe that societies that fostered fewer social relationships or had weak collective consciences were unhealthier, and suicide rates are one piece of the empirical evidence (Abrutyn and Mueller 2014).

This finding was consistent with previous studies. For instant, Blakey et al., 2003 suggest that being unemployed is associated with a twofold to the threefold increased relative risk of death by suicide, compared with being employed (Blakely, Collings and Atkinson 2003a). Howtitz et al. (2016) also suggest that suicide rates increased following the crash and decreased once economic stability resumed for males only (Hodwitz and Frey 2016). This indicated that traditional Durkheimian regulatory mechanisms, such as marriage and divorce, contributed to the gender-specific results (Hodwitz and Frey 2016).

Durkheim's suggested that egoistic suicide occur when an individual does not feel they are well integrated into society and religion, gender, education, marital status, and infertility can affect such integration. Similarly, anomic suicide occurs due to insufficient societal regulation on individuals such as economic crisis resulting in suffering and income level may determine such regulation. In agreement with this argument the result from this study suggest that marriage, fertility, higher income show a preservative effect on suicide. Individuals with low fortune are not married and have higher suicide, having family may neutralize the situation, and collective life will ensure integration.

Durkheim while describing egoistic suicide suggested that, women commit a lower rate of suicide as they are governed by fixed belief and has no greater intellectual need this study suggested that the opioid related overdose death was not affected by gender. Similarly, he suggested that educated group has higher tendency to suicide due to weakened traditional belief and individualism. However, the findings do not support this hypothesis as we observed that higher education was negatively associated with opioid related overdose deaths.

5.3 Empirical Implications

Though Durkheim's theory on suicide had been the most influential theory on suicide, it has been challenged on the theoretical and empirical grounds. First, Abrutyn et al., (2014) suggests that the classical Durkheim framework that describes suicide on two independent dimensions i.e., integration and regulation independently are largely flawed and should be expanded by integrating the emotional aspect of social psychology, psychology, and psychiatric research (Abrutyn and Mueller 2014). Thus, Abrutyn suggests that the structure and content of social relationships generate a socioemotional structure that shapes the context for suicide and this aspect should be included in the current framework. For example, shame might be evoked

when people perceive the social bond (integration) is threatened broken; people then control their behavior to avoid the shame that might lead to anger or sadness.

Second, Mueller et al. (2017) suggest that Durkheim provided little guidance regarding how group-level phenomena (integration and regulation) trickle down to affect individuals' suicide risk (Mueller, Abrutyn and Osborne 2017). As the analyses for this study were done at the county level, findings from this study do not truly reflect the individual inclination towards suicide and should be interpreted with cautious.

Third, Abrutyn et al. (2015) argues that a high level of integration is in and itself not always dangerous and a distinction should be made between healthy and harmful levels of integration (Abrutyn and Mueller 2015). They argue that integration is both an attribute of groups (and other micro-level social units) and individual-level identity dynamics (Abrutyn and Mueller 2015). However, no such distinction was made in the analysis thus future study should this into consideration.

Fourth, this study fails to sufficiently capture the Marxian concept of alienation of labor with the variable included in this analysis. Concept such as alienation from the object of production, alienation from the process or act of production, alienation from self or species being and alienation from fellow men were assumed to be integrated in the socioeconomic factor which might be subject to oversimplification.

Thus, the finding should be interpreted considering this limitation. Given the availability of the data, it is desirable for future empirical studies to incorporate other variables to address this issue.

5.4 Practical Implications

Rural definitions can be built on different units of geography that are sometimes combined with population or providers characteristics (Coburn et al. 2007). Although no single definition of rurality can serve all policy purpose, previous studies suggest several challenges with the varying definition of rurality (Atav and Darling 2012, Bennett et al. 2019, Coburn et al. 2007, Hart, Larson and Lishner 2005). For instant, inaccurate measures of rurality lead to confusion and inequity in the allocation of scarce resources that support projects and programs most effective for vulnerable rural populations (Atav and Darling 2012, Bennett et al. 2019).

However, this study finding suggests a durable relationship between opioid related overdose death and employment decline across various definition of rurality. This finding has several policy implications.

First, contrary to previous studies (Coburn et al. 2007, Hart, Larson and Lishner 2005) the findings suggest that single definition of rural will provide a general trend for the relationship between opioid related overdose death and employment decline or livelihood to drive resource allocation, grant funding eligibility, policy decisions as well as the decision for research and development. However, it is widely accepted and should be noted that to use resources in a more targeted approach, policy maker should consider key demographic and economic characteristics of the individual county.

Second, economic factors (e.g., unemployment) and source of livelihood (e.g., construction and mining) were strong predictor for the opioid related overdose death, primarily among rural counties. This showed the disproportionate impact of employment decline among rural communities. Thus, the distribution of tax incentives, infrastructure subsidies, training

programs, and other interventions should consider the variability of socioeconomic and livelihood characteristics across counties.

Third, community leaders should maintain and communicate their county statistics so that the community members are not deprived of the much-required federal resources with the use of varying rural definitions. These data will enable researchers to learn what rural America can do to overcome its liabilities.

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