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BRIEF REPORT

Associations of state-level rates of depression and fatal opioid overdose in the United States, 2011–2015

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Abstract

Purpose To assess the relationship between state-level depression and opioid overdose deaths between 2011 and 2015 in the United States.

Methods We assessed the association between percent of state populations reporting depression diagnoses and number of opioid analgesic-related deaths using negative binomial generalized estimating equations.

Results A 1% point increase in state-level depression diagnoses was associated with a 26% (95% CI 1–58%) increase in opioid analgesic-related deaths.

Conclusions Addressing depression in the provider–patient relationship may be important, as may be addressing the mental health provider shortage in the United States.

Keywords Depression · Mental health · Opioid · Overdose

Introduction

Opioids were the leading cause of overdose death in the United States in 2016, accounting for approximately 43,000 out of 66,632 overdose deaths [1]. As the crisis of opioid addiction and overdose continues, it has been estimated that over 500,000 people could die in the next 10 years due to opioid-related causes [2]. Several recent studies identified depression as both a risk and consequence of opioid use. Prior cohort and cross-sectional studies found that individuals with depression and other mental health conditions had higher rates of initiation and chronic use of opioid analgesics [3–5]. In addition, animal and human studies found depression may develop because of chronic opioid exposure [6, 7]. Given these findings, bidirectional associations between opioid use and mental health are likely. Only one study has, to the best of our knowledge, examined the role of depression in fatal opioid overdoses. The study found individuals who died due to unintentional opioid overdose in Utah were more likely to have a history of mental illness, primarily depression [8].

The purpose of this study was to determine if state-level rates of depression were associated with state-level fatal opioid overdose deaths in the United States from 2011 to 2015. If depression and fatal opioid overdose deaths are significantly associated, it may be important to consider mental health in interventions and legislation targeting opioid misuse and overdose.

Methods

We conducted a retrospective ecological study of the association between state-level estimates of opioid-related overdose deaths and percent of state populations reporting depression in the United States.

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Outcomes

We abstracted the number of opioid analgesic-related overdose deaths in each state in the United States from 2011 to 2015 from the Wide-ranging Online Data for Epidemiological Research from the Centers for Disease Control and Prevention [9]. For the primary analyses, we categorized fatal drug overdoses of any intent (ICD-10 codes X40–X44, X60–X64, Y10–Y14) where an opioid analgesic was also indicated (T40.2–T40.4) as an opioid analgesic-related death. This categorization captured all deaths in which an opioid analgesic was a contributing factor and has been used in previous studies of opioid deaths [10]. For the follow-up analyses, we included two alternative categorizations of opioid deaths. In the first, we excluded intentional deaths so the outcome was only unintentional fatal drug overdoses involving an opioid analgesic. In the second, we included all opioid-related deaths, including illicit opioids.

Exposure

Depression data were from the Behavioral Risk Factor Surveillance System (BRFSS), a landline and cellular telephone survey in the United States that collected information about health-related behaviors and outcomes [11]. More than 400,000 adults across the United States participated [11]. The Prevalence and Trends Data Tools, an online analysis interface, reported state-level estimates [12]. For this analysis, we abstracted the percent of the state population with a self-reported depression diagnoses for each year.

Covariates

Based on prior literature on risk and protective factors for opioid misuse and overdose, we included the following covariates in the adjusted models: percent of the state reporting poor/fair health per year, percent of the state population uninsured per year, and a dichotomous variable indicating if the state had a policy allowing medical marijuana in each year. We abstracted state-level reports of health from the BRFSS following the used for depression data [11]. We abstracted data on the percent of the state population lacking health insurance from the United States Census Bureau American Fact Finder [13]. Information on insurance status was abstracted from the United States Census Bureau American Community Survey, a nationwide survey of more than 3.5 million houses across the United States conducted through internet, mail, telephone, and in-person interview [14]. The National Conference of State Legislatures, a bi-partisan non-governmental organization that provides policy-relevant information to state legislators, published data on state marijuana policies [15]. As marijuana policies may be implemented throughout the year, we categorized states with a marijuana policy implemented during the first 6 months of the year as having a marijuana policy and states with a marijuana policy implemented during the second 6 months of the year as having a policy for the next year. We also considered unemployment, as reported by the Bureau of Labor Statistics, as a covariate; however, we found evidence to suggest unemployment was a moderator of the relationship between depression and opioid analgesic overdose [16]. Reporting of these complex results was outside the scope of this brief report.

Statistical analyses

We assessed the state-level association between depression and opioid-related deaths using negative binomial generalized estimating equations (GEE), which accounted for the non-independence across observations. For all models, our primary exposure variable was state depression percentages and the offset, which accounted for differences in state populations, was the log of the state population. For the primary analysis, we modeled the outcome as count of deaths per state that included at least one opioid analgesic, including deaths that also involved illicit drugs or more than one drug (model 1). To assess the robustness of our findings, we conducted a series of follow-up analyses. First, we conducted separate negative binomial regression analyses for each year with state as a fixed effect, which confirmed the magnitude and significance of the results were not dependent upon specification of the GEE parameters (results not tabled). Next, we excluded all intentional opioid analgesic deaths (e.g., suicide) to assess the relationship between depression and only unintentional opioid analgesic-related deaths (model 2). Finally, we modeled the associations between depression and all opioid-related deaths, including heroin and opium regardless of opioid analgesic presence (model 3). Prior to finalizing the results, we confirmed the statistical assumptions of the models were appropriately met.

Results

On average, rates of opioid analgesic-related deaths remained stable in 2011, 2012 and 2013 (approximately 5 deaths per 100,000 persons), but increased substantially in 2014 (5.9 deaths per 100,000 persons) and 2015 (7.0 deaths per 100,000 persons). In 2015, South Dakota had the lowest rate of opioid analgesic-related deaths at 2.4 deaths per 100,000 persons and West Virginia had the highest at 27.7 deaths per 100,000 persons. Approximately 19% of the United States population reported a depression diagnoses in 2015, up from 17.5% in 2011. In 2015, Oregon had the

Table 1 Associations of depression and fatal opioid overdose in US states and the District of Columbia

	Primary analysis[a]		Secondary analysis[a]			
	Crude IRR[b] (95% CI)	Adjusted IRR[b,c] (95% CI)	Crude IRR[d] (95% CI)	Adjusted IRR[c,d] (95% CI)	Crude IRR[e] (95% CI)	Adjusted IRR[c,e] (95% CI)
Depression[f]	1.32 (1.05–1.67)	1.26 (1.01–1.58)	1.38 (1.07–1.79)	1.31 (1.03–1.68)	1.38 (1.11–1.73)	1.33 (1.07–1.67)

[a]GEE models that account for state and year effects (2011–2015)

[b]Model 1 includes deaths due to 'other opioids', 'methadone', and 'other synthetic narcotics'

[c]Adjusted analyses control for state-level reports of health, percent insurance status, and medical marijuana policies

[d]Model 2 excludes opioid analgesic deaths due to suicide and other intentional methods

[e]Model 3 includes all opioid-related overdose deaths, even if no opioid analgesic was involved

[f]One percentage point increase in state population reporting depression diagnosis

highest percentage of depression (26.7%), while Hawaii had the lowest (11.6%).

Depression was strongly associated with opioid analgesic-related deaths in the United States between 2011 and 2015. A 1% point increase in self-reported depression diagnoses was associated with a 26% (95% CI 1–58%) increase in opioid analgesic-related deaths, after adjusting for state general health, insurance status, and medical marijuana policies (Table 1: model 1). This relationship persisted for unintentional deaths due to opioid analgesic overdose (IRR 1.31; 95% CI 1.03–1.68; Table 1: model 2) and overdose deaths due to any opioid (IRR 1.33; 95% CI 1.07–1.67; Table 1: model 3).

Discussion

We found a strong relationship between depression rates and opioid analgesic-related death rates. Given the bidirectional relationship between depression and opioid use in previous literature, these findings support the need for multiple approaches to opioid overdose prevention. Nearly two-thirds of opioid overdoses involve prescription opioids; thus the patient–provider relationship may be an important tool to prevent and treat comorbid opioid misuse and depression [17]. Providers may need to screen for depression prior to prescribing opioids and discuss the risk of depression with the patient. If opioids are the preferred treatment approach after screening, it may be beneficial to have discussions with patients, especially those with depression, about opioid addiction and how to seek help. In addition, providers may need to continue screening and talking about depression with their patients during treatment to address developing symptoms. For many reasons, providers may be unable to have these conversations so it may be necessary to have other professionals engaged for this purpose.

Increasing access to mental health services may also play an important role in reducing opioid overdose. In the United States, only 44.2% of mental health care need is met, and more than 3000 additional mental health providers would be necessary to address the shortage [18]. West Virginia, for example, had the highest rate of opioid death in 2015 and nearly a million residents live in areas with a mental health care professional shortage [18]. Given the relationship between depression and opioid overdose, reducing this shortage of mental health providers may also reduce the number of opioid overdose deaths.

Limitations

As an ecological analysis, these results may not persist at the individual-level and should not be interpreted as causal. Future research at the individual-level is necessary. In addition, the analyses were limited to the available state-level data. Addition covariates, such as trauma history, overdose, and/or suicide in the social network, may be important to consider. Longitudinal individual-level analyses may also provide additional insights into the directionality of the association between depression and opioid misuse.

Conclusion

As the opioid epidemic in the United States continues to grow at an unprecedented rate, there is a need for public health interventions to reduce opioid overdose deaths. Future research is necessary to provide empirical support for interventions that reduce opioid overdose deaths by ameliorating mental health issues.

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Compliance with ethical standards

Conflict of interest On behalf of all authors, the corresponding author states that there is no conflict of interest.

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