Shifting Perspective – Can Behavioral Health Care Resources Reduce State Firearm Homicide Rates?

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Abstract

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Introduction

Firearm homicide rates have risen steadily over the last decade. Two potential forms of intervention discussed by policy makers include firearm safety legislation and behavioral health resources. We sought to determine if a relationship exists between a state's behavioral health resources and firearm related homicide rate.

Methods

We conducted a time-series cross-sectional analysis using the state and year as the unit of analysis. Data from 2010 to 2018 were obtained from multiple publicly available sources. Age-adjusted firearm homicide rate served as the main outcome variable. The main explanatory variables were number of behavioral health care workers, number of mental health treatment facilities, and mental health care expenditure. Additional covariates included socioeconomic factors, demographic factors, and firearm factors. Fixed effects linear regression was used to

analyze the association between firearm homicide rate and behavioral health workforce, number of treatment facilities, and spending per capita.

Results

Mean age adjusted homicide rate increased during the study period, with an overall increased by 27% in 2018 (4.43 per 100,000) compared to 2010 (3.49 per 100,000). During this period, the states with highest age-adjusted firearm homicide rate included the District of Columbia, Louisiana, and Mississippi. Mean behavioral health care workers per state increased by 9.4% (2010: 224 per 100,000; 2018: 245 per 100,000). Mental health care facilities initially increased from 2010 (4 per 100,000) to 2012 (5.8 per 100,000) but demonstrated a steady decline thereafter.

Unadjusted fixed effects modelling showed no significant relationship between behavioral workforce, mental health facilities, or spending per capita and firearm related homicide. After adjusting for socioeconomic and demographic variables, this association remained non-significant.

Conclusion

Behavioral health resources in the form of workforce, facilities, and spending per capita is not associated with firearm homicide rates on a state level.

Introduction

The right to bear arms has shaped this country in many ways. In the public health sphere, firearms have been studied in the context of intimate partner violence, suicide, and homicide. Most firearm deaths are due to suicide, and studies advocate for addressing the firearm suicide crisis from multiple angles.[1,2] Firearm homicides have also come under attention of policy makers and advocacy groups as despite the decreasing trend in rates of homicide from 1980 to 2016 the proportion of firearm related homicide within the total has increased from 63% to 76%.[3]

With the goal of introducing preventative measures to reduce firearm death rates, two potential forms of intervention discussed by policy makers include firearm safety legislation and behavioral health resources. Within the realm of firearm safety legislation, some studies have shown measurable reduction in firearm homicide rate with firearm safety legislation.[4–7] In particular, background checks and waiting periods were most strongly associated with decreased forearm homicide rates while most other forms of firearm safety legislation shows inconclusive evidence of efficacy in decreasing violent crime.[7]

Behavioral health focuses on both those who injure and are injured by firearms. Behavioral health encompasses both mental and physical health and includes substance use disorders and other risk-taking behaviors. The significance of the broader definition of behavioral health over mental health is the tenuous association between mental health disorders and violence. Studies have found that substance use is a risk factor for firearm perpetration, while mental health disorders are not.[8,9] Furthermore, those with behavioral health illnesses have a four times

higher incidence of being victims of violent crime compared to the general population.[10] Therefore it follows that an increase in behavioral health resources could impact the health and social circumstances of these individuals through providing resources for housing, recovery from substance use, and ultimately creating a safer environment and thus lead to fewer firearm related homicides.

Although studies have shown that increasing behavioral health resources decreases firearm suicide rates, no recent study has examined the association between behavioral health resources and firearm homicide.[11] One older study examined the relationship between firearm homicide and mental health care resources, and found an association between clinically active mental health personnel, the number of mental health facilities, and the number of persons covered by mental health insurance with lower firearm homicide rates within a state. However, this study only examined the year 2002, and did not study trends over time.[12] In our study, we aim to determine the association between a state's behavioral health resources, measured through three behavioral health variables (behavioral health workforce, behavioral health facilities, and behavioral/mental health spending per capita), and the number of firearm related homicide incidents within that state from 2010 to 2018. We hypothesize that there will be a small association between behavioral health resources and firearm homicide.

Methods

Study Design and Data Collection

We conducted a time-series cross-sectional analysis using the state and year as the unit of analysis. Data from 2010 to 2018 were obtained from multiple publicly available sources

including the CDC's WISQARS database including restricted micro-level data[13], Substance Abuse and Mental Health Services Administration (SAMHSA) surveys[14], the US Census[15], and the US Bureau of Labor Statistics data[16]. The years 2011 and 2013 were excluded as these years were not included in the SAMHSA surveys, and so key exposure variables were unable to be obtained from those years. Study subjects included all 50 states and Washington D.C. but did not include US territories due to data being unavailable from these territories.

Exposures

The main explanatory variables included: number of behavioral health care workers (per 100,000), number of mental health treatment facilities (per 100,000), and mental health care expenditure (per capita). Behavioral health care workers were calculated by the sum of several occupation counts, obtained through the US Bureau of Labor Statistics database. These occupations included clinical, counseling, and school psychologists (19-3031), substance abuse and behavioral disorder counselors (21-1011), mental health counselors (21-1014), medical and public health social workers (21-1011), psychiatrists (29-1066), psychiatric aides (31-1013), and mental health and substance abuse social workers (21-1023). Number of facilities were obtained from the SAMHSA Mental Health Services Survey and included psychiatric hospitals, general hospitals providing psychiatric care, residential treatment facilities, Veterans Administration medical centers, and community mental health centers. The sum of the counts for both workforce and facilities was normalized for the population of the state by calculating values as count per 100,000 in the state's population. Mental health care expenditure was obtained from the SAMHSA Uniform Reporting System State reports, which reports each state's mental health care spending per capita per year. SAMHSA Uniform Reporting System State

reports for 2016 did not calculate a per capita spending, and so a linear interpolation was applied using data from adjacent years (2015 and 2017) to calculate a value for 2016.

Outcome

The primary outcome of interest was firearm related homicide per 100,000 in the population for each state per year. This included firearm related homicide and excluded firearm related suicide and firearm related deaths from police intervention. This value was age-adjusted based on a standard population in 2000 to account for differences in incidence of firearm homicide across age groups and differences in age distributions between states.

Covariables

We considered several proxies for firearm ownership and chose the ratio of firearm suicide to total suicide. This proxy is widely used and has been shown to be closely correlated to firearm ownership.[17] Furthermore, this proxy is available for all years of interest for this study.

Prevalence of mental illness within a state was also included as a covariable due to its role in determining the amount of behavioral and mental health resources allocated to a state. This variable was obtained by the National Survey on Drug use and Health (NSDUH) and included those 18 years and older with any mental illness defined as having a diagnosable mental, behavioral, or emotional disorder assessed by the Mental Health Surveillance Study (MHSS) Structured Clinical Interview for the Diagnostic and Statistical Manual of Mental Disorders (4th Edition). The values are presented as state estimates based on a survey-weighted hierarchical Bayes estimation approach generated by Markov Chain Monte Carlo techniques.[18] We also considered socioeconomic variables including the annual unemployment rate, high school

graduation rate, and median household income. Prior studies have shown economic insecurity as an important association to the rise in gun violence within the US, which would potentially confound the relationship between behavioral health resources and gun homicide.[19]

Positive Control

Firearm safety legislation has been associated with firearm homicide rate in multiple prior studies.[4,20] We expect this measure to also show an association with firearm homicide rate within our study and models, and therefore included this variable within our analyses to reassure the validity of our model. This count was obtained through the Boston University School of Public Health's State Firearm Laws database.[21] This method gives equal weight to each law by using a count, which we recognize is not the most precise method to determine the impact of safety legislation on homicide. Each form of legislation has complex influences in each state, and the infrastructure within the state may further determine how a law is enforced. Determining these nuances is outside the scope of this study, and for the purposes of a positive control, we determined the total count to be an adequate measure of more stringent legislation.

Statistical Analysis

Multivariable fixed effects linear regression was used to analyze the association between firearm homicide rate and behavioral health workforce, number of treatment facilities, and spending per capita. We chose fixed effects regression as a method to control for time-invariant characteristics of each state that could potentially confound the relationship between behavioral health variables and firearm homicide rate. Year and state were used as fixed

effects. Robust standard errors were used to account for heteroskedasticity. Each outcome measure was analyzed individually using separate models. Each model adjusted for high school graduation rate, unemployment rate, median household income, sex, race, prevalence of mental illness, and firearm ownership as confounders. We determined an a priori significance level of 0.05.

Results

Corroborating past studies, mean age adjusted homicide rate increased during the study period, with an overall increased by 27% in 2018 (4.43 per 100,000) compared to 2010 (3.49 per 100,000) (Table 1).[3] During this period, the states with highest age-adjusted firearm homicide rate included the District of Columbia, Louisiana, and Mississippi (Table 2). Mean behavioral health care workers per state increased by 9.4% (2010: 224 per 100,000; 2018: 245 per 100,000). Mental health care facilities initially increased from 2010 (4 per 100,000) to 2012 (5.8 per 100,000) but demonstrated a steady decline thereafter. Firearm ownership rate remained relatively stable ranging from a low of 49.1% to a high of 50.8%. During this same period, there was a dramatic decrease in unemployment rate from 8.8% in 2010 to 3.8% in 2018 along with an increase in median household income from $57,730 in 2010 to $64,411 in 2018. Race, high school graduation rate, and sex distributions did not change noticeably during this period.

Unadjusted fixed effects modelling showed a significant association between firearm safety legislation and firearm homicide rates (Table 3). States with a higher number of firearm safety laws by 10 was associated with a lower firearm homicide rate by 0.59 deaths (95% CI -0.97, -

0.2, p 0.004). This relationship remained significant after controlling for high school graduation rate, unemployment rate, median household income, percent male, race, and prevalence of mental illness (coefficient -0.63, 95% CI -1.0, -0.2, p 0.002) (Table 4).

Unadjusted fixed effects modelling for the main explanatory variable showed a trend towards lower firearm homicide rates with higher behavioral healthcare workforce and mental health facilities, but this relationship was not statistically significant (Table 3). Mental health expenditure was also not significantly associated with firearm homicide rates. After adjusting for high school graduation rate, unemployment rate, median household income, sex, race, prevalence of mental illness, and firearm ownership rate, the associated with firearm homicide rate remained non-significant (Table 4).

Discussion

This study demonstrates that behavioral health resources in the form of workforce, facilities, and spending per capita is not associated with firearm homicide rates. Despite our hypothesis that behavioral healthcare interventions may help prevent firearm homicides through interventions related to substance use, housing, and other benefits, it is not entirely surprising that on a state level there was no association between the two factors. Firearm safety legislation count was however significantly associated with firearm homicide rate, consistent with prior studies. Furthermore, as an ecologic study, our conclusions cannot be extended to an individual level, and so the question of how behavioral health intervention may impact the individual's risk of firearm homicide is still in question.

The variables used for this study to measure behavioral health resources were those that were accessible publicly but are imprecise. For example, we were able to obtain the number of behavioral healthcare workforce in a state, however not all of these workers are likely to be involved in working with those at risk for violence. The data available is not granular enough to distinguish psychiatrists who treat substance abuse and other known associations with violence with those who treat depression or anxiety. Therefore, even if those who treat behavioral health disorders associated with violence, their impact is diluted when considering all psychiatrists working in a state. Furthermore, behavioral health care resources extend beyond workforce, facilities, and funding, and may be better represented by specific intervention programs. As an example, San Francisco General Hospital employed hospital-based violence intervention programs (VIPs) with the goal to reduce recidivism. Participants in the program were assigned case managers who worked intensively with their client to link them with resources in the community, provide court advocacy, and implemented other prevention strategies. They found that this violence intervention program led to a nearly fourfold decrease in injury recidivism (from 16% to 4.5%).[22] In particular, mental health and employment referral/placement resources were the most predictive of success, supporting our hypothesis that increased resources in these sorts of behavioral health programs may impact firearm homicide rates. Supporting the potential for violence intervention programs to reduce firearm related injury and death, the Juvenile Weapons Offenders Program in Miami-Dade County specifically addressed violence education and intervention in the context of firearm recidivism. This program demonstrated a significant reduction by half of recidivism rates for those enrolled in the program.[23] These programs are however institution specific, and due to the variability in

the individual programs, it would be difficult to compile and study the effect of these programs on a statewide or nationwide level. However, the results from these intervention programs indicate that increasing overall behavioral health resources could ultimately support more hospital-based violence intervention programs and decrease recidivism rates and firearm homicide.

We also recognize that our measure of behavioral health care resources does not measure the quality of the care provided in each state or access to care. Understanding the distribution of healthcare resources and measuring unmet need is a better representation of the efficacy of behavioral healthcare resources, and this level of granularity would likely need to be done for the county or zip code level due to the heterogeneity of a state's population. However, this level of data collection and analysis was outside the scope of this project.

With rising concerns for worsening firearm injury and mortality rates, it is of vital importance to explore all possible domains to prevent further injury and mortality. Despite not finding an association between behavioral health resources and firearm homicide on a state level, with the data available in recent single institution studies in regards to behavioral health related interventions showing success in reducing injury recidivism, it is possible that increased support in these sorts of programs and interventions could lead to a measurable association with behavioral health resources and firearm homicide in future studies.

Conclusions:

Behavioral health resources in the form of workforce, facilities, and spending per capita is not associated with firearm homicide rates. However, recently developed targeted interventions

within the umbrella of behavioral health care have shown improvements in injury recidivism, making it possible that an association between behavioral health resources and firearm homicide may develop with widespread adoption of similar injury prevention programs.

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Table 1. Average values per state by year, behavioral health, demographic, and firearm measures (n = 357[1]).

	2010	2012	2014	2015	2016	2017	2018
Outcome Measure							
Age adjusted homicide rate (per 100,000)	3.49	3.37	3.25	4.03	4.39	4.42	4.43
Explanatory Variables							
Behavior health workforce (per 100,000)	224	228	227	234	238	238	245
Mental health facilities (per 100,000)	4	5.8	5.6	5.4	5.1	4.8	4.8
Mental health care expenditure per capita	123	129	136	145	139	133	135
Demographic Variables							
High school graduation (%)	89	90	90	91	90	91	91
Median household income	57730	56985	58633	60427	61925	63017	64411
Race (%)							
White	77.3	76.9	76.5	76.3	75.9	78.8	75.5
Black	11.1	11.2	11.3	11.2	11.3	12.5	11.3
Male (%)	49.3	49.3	49.4	49.4	49.4	49.4	49.4
Annual unemployment rate (%)	8.8	7.4	5.8	5	4.7	4.2	3.8
Mental illness prevalence (%)	18.7	18.7	18.9	18.7	18.7	19.3	19.9
Firearm ownership (%)	50.8	50.5	49.5	49.1	50.4	49.8	50.1

[1]Total n refers to the number of state-years (50 states and Washington D.C. with 7 years each).

Table 2: States with highest firearm homicide rates averaged over 2010-2018

State	Age-adjusted firearm homicide rate (per 100,000)
District of Columbia	11.42
Louisiana	10.37
Mississippi	9.17
Alabama	8.3
Missouri	7.45
South Carolina	6.6
Maryland	6.48
Tennessee	6.06
Arkansas	5.92
Illinois	5.89

Table 3: Unadjusted fixed effects linear regression demonstrates no significant relationship between behavioral health variables and firearm homicide rate.

Explanatory Variable	Coefficient	95% Confidence Interval	P-value
Behavioral Health Workforce[1]	-0.27	-0.7, 0.2	0.220
Mental Health Facilities[2]	-0.69	-1.9, 0.5	0.247
Mental Health Expenditure[3]	0.14	-0.2, 0.5	0.419
Positive Control			
Count of Firearm Laws[4]	-0.59	-0.97, -0.2	0.004*

[1]Coefficient presented as an increase in 100 workers per 100,000 in the population leading to a 0.27 lower firearm homicide rate per state

[2]Coefficient presented as an increase in 10 facilities per 100,000 in the population leading to a 0.69 lower firearm homicide rate per state

[3]Coefficient presented as an increase in $100 increased spending per capita leading to a 0.14 higher firearm homicide rate per state

[4]Coefficient presented as an increase in 10 laws per state leading to a 0.59 lower firearm homicide rate per state

Table 4: Adjusted fixed effects linear regression demonstrates no significant relationship between behavioral health variables and firearm homicide rate.

Explanatory Variable[a]	**Coefficient**	**95% Confidence Interval**	**P-value**
Behavioral Health Workforce[1]	-0.14	-0.6, 0.3	0.509
Mental Health Facilities[2]	-0.64	-1.7, 0.4	0.213
Mental Health Expenditure[3]	0.11	-0.2, 0.4	0.531
Positive Control[b]			
Count of Firearm Laws[4]	-0.63	-1.0, -0.2	0.002*

[a]Adjusted for: high school graduation rate, unemployment rate, median household income, percent male, race, prevalence of mental illness, and firearm ownership.

[b] Adjusted for: high school graduation rate, unemployment rate, median household income, percent male, race, and prevalence of mental illness.

[1]Coefficient presented as an increase in 100 workers per 100,000 in the population leading to a 0.14 lower firearm homicide rate per state

[2]Coefficient presented as an increase in 10 facilities per 100,000 in the population leading to a 0.64 lower firearm homicide rate per state

[3]Coefficient presented as an increase in $100 increased spending per capita leading to a 0.11 higher firearm homicide rate per state

[4]Coefficient presented as an increase in 10 laws per state leading to a 0.59 lower firearm homicide rate per state