Association between medical diagnoses and suicide in a Medicaid beneficiary population, North Carolina 2014-2017

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Abstract

Background: Firearms are used in about half of U.S. suicides. This study investigated how various medical diagnoses are associated with firearm and non-firearm suicide.

Methods: We used a case–control design including n=691 North Carolina Medicaid beneficiaries who died from suicide between 1 Jan 2014-31 Dec 2017 as cases. We selected a total of n=68,682 controls (~1:100 case–control ratio from North Carolina Medicaid member files using incidence density sampling methods. We linked Medicaid claims to the North Carolina Violent Death Reporting System to ascertain suicide and means (firearm or non-firearm). We matched cases and controls on number of months covered by Medicaid over the past 36 months. Analyses adjusted for sex, race, age, Supplemental Security Income status, the Charlson Comorbidity Index, and frequency of health care encounters.

Results: The case–control odds ratios (ccORs) for any mental health disorder were 4.2 (95% confidence interval (CI): 3.3, 5.2) for non-firearm suicide and 2.2 (95% CI: 1.7, 2.9) for firearm suicide. There was effect measure modification by sex and race. Behavioral health diagnoses were more strongly associated with non-firearm suicides than firearm suicide in men but did not

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differ substantially in women. The association of mental health and substance use diagnoses with suicides appeared to be weaker in Blacks (vs non-Blacks), but the estimates were imprecise.

Conclusions: Behavioral health diagnoses are important indicators of risk of suicide. However, these associations differ by means of suicide and sex, and associations for firearm-related suicide are weaker in men than women.

Keywords

suicide; firearm; mental health; substance use; Medicaid; claims

Introduction

Suicide rates in the United States (U.S.) have increased about 35% since 1999,[1] and there is considerable concern that social and economic stresses related to the global coronavirus pandemic may accelerate this trend.[2] About half of suicide deaths in the U.S. are the result of self-inflicted firearm injuries, a larger proportion than in comparable countries.[3,4] The U.S. accounts for about one-third of annual firearm suicide deaths worldwide, despite having less than 5% of the global population.[5]

Improving the capacity of healthcare organizations to identify those patients at risk of suicide is an important public health goal.[6,7] However, relatively little is known about diagnostic predictors of suicide in the U.S. civilian population, in part due to the challenges inherent in conducting large population-based administrative linkages with diagnostic data in this country.[8] In contrast, there are multiple large studies of diagnostic predictors in U.S. military populations and civilian populations outside the U.S.[9–15]

Firearms are the most lethal means of inflicting self-injury.[16] Suicide by firearm differs from suicide via other means in several important respects.[16] Many of these relate to the fact that the decision to self-inflict lethal injury is sometimes made with a high degree of impulsivity.[3] About two-thirds of people attempting suicide will not repeat the attempt if they survive.[17] It is estimated that the majority of firearm suicide attempts are fatal (90.9% in men and 79.6% in women).[16] By comparison, the second most common means of suicide (self-poisoning) is far less lethal (3.3% of self-poisoning attempts result in fatality in men and 1.5% in women).[16] Thus, the probability of long-term survival is optimized if a firearm suicide attempt can be prevented or transitioned to less lethal means. Accordingly, an important strategy for preventing suicide is limiting access to lethal means during high-risk periods.[18] One widely cited example of this prevention strategy is a policy intervention implemented by the Israeli Defense Force in 2006, wherein soldiers were required to leave their firearms on base when they went home for the weekend.[19] This intervention is credited with reducing the suicide rate among Israeli soldiers by 40%.[19]

Because people who impulsively attempt suicide with a firearm are more likely to die than people who impulsively attempt suicide using any other means, it is not surprising that these individuals also appear to have different diagnostic profiles. For individuals who impulsively engage in a highly lethal form of self-injury, their "opportunity" to be diagnosed with a behavioral health (mental health or substance use) disorder may be relatively brief, even in

the presence of an underlying chronic mental health or other condition. A recent study of 2,674 suicide decedents and 267,400 matched controls reported that diagnostic conditions tended to be more predictive of suicide by non-firearm means than suicide by firearm means.[20] These findings have important implications as health systems move towards the use of machine learning prediction techniques to identify patients at risk of poor outcomes, such as suicide. They suggest that training separate predictive algorithms for firearm suicide may be beneficial.

This paper extends prior research, which was limited to predominantly privately insured patients,[20] by investigating associations of medical diagnoses with firearm and non-firearm suicides among publicly insured Medicaid beneficiaries in North Carolina from 2014-2017. The Medicaid population exhibits increased incidence of suicide risk factors, diagnostic and otherwise.[21–24] Medicaid beneficiaries may be amenable to suicide prevention interventions as they are already engaged in public programming. Integrating suicide prevention into the Centers for Medicare & Medicaid Services (CMS) policies is a stated priority area in the Surgeon General's 2012 National Strategy for Suicide Prevention.[7] Suicide rates vary substantially by sex and race.[25,26] Therefore, we also investigated effect measure modification by sex and race, an issue that has not been addressed.[20]

Methods

This study used a case–control design to quantify the association between mental and physical health diagnoses and firearm and non-firearm suicide in a beneficiary population. Medicaid claims were used to identify medical diagnoses thought to be predictive of suicide based on prior research.[20] Medicaid claims were linked to data from the North Carolina Violent Death Reporting System (NC-VDRS) to ascertain suicide status.

Population

The study population was beneficiaries   10 years of age who were covered between 1 January 2013 and 31 December 2017 by North Carolina (NC) Medicaid for at least 12 continuous months. A person was considered "covered" if they met the age requirement and were enrolled in Medicaid under family planning for low-income people, managed care for behavioral health services, Medicare-Aid, North Carolina Health Choice (coverage for children), or general Medicaid (Figure 1). Women who received Medicaid coverage only for pregnancy-related care were not included.

Data Sources and Linkage

We linked the NC Medicaid enrollment and claims data to suicide (N=5,732) or decedents with undetermined intent (N=260) identified by the NC-VDRS as having died between 1 January 2014 – 31 December 2017. We restricted the linkage to people >10 years of age. The NC-VDRS is part of the National Violent Death Reporting System (NVDRS), a surveillance system for fatal intentional injury developed by the U.S. Centers for Disease Control and Prevention (CDC). The NVDRS utilizes death certificates, law enforcement reports, medical examiner reports, and toxicology to collect comprehensive circumstantial information on violent deaths, including suicide. The NC Division of Health Benefits (the

state government entity that oversees NC Medicaid), which acted as an honest broker, conducted a deterministic linkage between NC-VDRS and the Medicaid files, using exact matches on name, date of birth, and sex.

Ascertainment of cases and controls

We considered a case any Medicaid enrollee linked to a suicide death and ≥ 10 years of age in the NC-VDRS records. We sampled non-decedent controls (≥ 10 years of age) from North Carolina Medicaid enrollment using incidence density sampling at a ratio of 100:1 during the month and year corresponding to the date of each case's death. We assessed diagnoses for cases and controls retrospectively from claims data in months prior to the index month using "lookback periods" defined by the CMS (Table 1).[27] Cases were eligible to serve as controls prior to becoming cases. We conducted control sampling with replacement, meaning that an individual could serve as a control for multiple cases in separate months but not in the same month.[28] We matched sampled cases and controls on coverage duration (number of months covered over the past three years: ≤ 12, 13-24, or ≥ 25 months).

Variable definitions

The NC-VDRS definition of suicide is "a death resulting from the intentional use of force against oneself."[29] There is evidence that suicide is underdiagnosed in certain minority populations.[30–32] For this reason, we also included violent deaths designated as "undetermined intent" by NC-VDRS. This study categorized the suicide outcome as "firearm" or "non-firearm", according to the method of self-inflicted injury, as determined by NC-VDRS.[29]

This study evaluated diagnoses, as documented in Medicaid claims, that are commonly considered suicide risk factors in the literature: depression, anxiety, bipolar disorder, schizophrenia, drug use disorder, opioid use disorder, alcohol use disorder, epilepsy, traumatic brain injury (TBI), and fibromyalgia, chronic pain, and sleep disorders. We based diagnostic criteria on algorithms developed by CMS specifying ICD-9 CM and ICD-10 CM diagnosis codes, claim type criteria, and "lookback periods" specific to each diagnosis.[27] The lookback (or reference period) was 2 years for all diagnoses except depression, which was 1 year. Claim type refers to service location (inpatient, outpatient, skilled nursing, etc.). Often, the algorithms required one inpatient claim, or two claims from a specified set of additional locations, to endorse a specific diagnosis.

The adjustment set was based on a theory-informed directed acyclic graph, which identified measured ancestor correlates (which were not considered to be on the causal path) of both the diagnostic exposures and the outcome of suicide. These were age (coded as a quadratic splines with knots at 20, 50, and 70 years, and with the upper and lower tails restricted to linear segments); sex (male/ female); race (Black/ non-Black); the Charlson Comorbidity Index (CCI),[34] which reflects a variety of physical conditions that impact survival; Supplemental Security Income (SSI) status (present/not present—this benefit is extended to individuals <65 years of age who are disabled and who have very limited income and financial resources); number of encounters (inpatient or outpatient) beneficiaries had in the 90 days prior to the index month; and lastly, coverage duration. Race was

included in the model as an indicator of structural racism and culture, which could affect whether a patient is diagnosed with a condition and whether that person's death is attributed to suicide. This sample was not subject to missing data with the exception of a small number of people whose race was designated as "unreported", and this were categorized as "non-Black".

Analysis

We used conditional logistic regression models, accounting for matching by coverage duration, to estimate case–control odds ratios (ccOR) for associations between diagnoses and suicide according to suicide method. We adjusted all ccORs for the adjustment variables listed in the previous paragraph. We used ninety-five percent confidence intervals and confidence limit ratios[35]—the ratio of the upper to the lower confidence limit—to quantify the precision of the ccORs. To examine effect measure modification, we stratified analyses by sex and race. This study's coverage requirement of 12 continuous months prior to the index date is more lengthy than some similar studies,[20,36,37] but was chosen to maintain internal validity, and coverage for any 6 of the previous 12 months was explored in a sensitivity analysis. Additional sensitivity analyses explored the effect of adjustment for the variables in the adjustment set (listed in the previous paragraph), matched versus unmatched models, and the exclusion of cases where the violent death was designated as undetermined intent. Although time-varying confounding in the presence of multiple behavioral health diagnoses was likely in this sample, common methods to address this confounding are not appropriate for our data, where the temporality of diagnoses for complex and often chronic conditions was impossible to establish with confidence. To characterize this unmeasured confounding, we used quantitative bias analyses to explore how robust the association between depression and suicide among men would be in the presence of a strong confounder (modeled after anxiety), where the confounder took on different combinations of confounder prevalence and confounder-suicide associations.[38] Because controls were sampled using an incidence density technique (i.e., controls were selected from the enrolled population in the index months of death for the cases), the ccORs approximate the incidence rate ratios that would be obtained from a hypothetical prospective cohort study of this population. All analyses used SAS 9.4 (Cary, NC) and data harmonization and computational code is available.[39]

This study was approved by the Institutional Review Board at the University of North Carolina at Chapel Hill. Pursuant to Medicaid data use agreement constraints designed to limit the potential for deductive disclosure, we reported counts less than or equal to 10 as " 10". Additionally, counts greater than 10 that had potential for deductive disclosure by virtue of subtraction from reported totals are reported as "NR" (not reported). We also do not report ccORs that, due to small cell counts, have poor precision (defined as a confidence limit ratio[35] 30).

Results

The NC-VDRS indicated that 5,732 people died of suicide in NC during the 2014-2017 study period, and 260 died of undetermined intent. There were 3,127,576 Medicaid

enrollees in NC from 2014-2017, of whom 691 met inclusion criteria and linked to the NC-VDRS death data for suicide or undetermined intent. Women were more commonly controls because the Medicaid population is disproportionately composed of single mothers. The most common means of suicide death were firearms (n=255), poisoning (n=227), and hanging (n=152), followed by others (n=57). Among women, 283 suicide cases met inclusion criteria, including 65 (23%) deaths attributed to firearms (Table 1, Figure 2). Among men there were 408 suicide cases, including 190 (47%) firearm deaths. Deaths due to undetermined intent contributed n=57 (8%) to the sample (n=28 or 10% for women and n=29 or 7% for men). Among men and women, firearm suicide decedents were more likely to have White race and not receiving SSI, compared to non-firearm suicide decedents (Table 1). The study included 68,682 controls selected using incidence density sampling according to the month and year of the suicide deaths among cases.

Mental health and substance use disorders were strongly associated with both firearm and non-firearm suicides; however, the association was stronger for non-firearm suicides in the combined population of men and women (Table 2). Having any mental health disorder was strongly associated with increased odds of both non-firearm suicide (ccOR of 4.2; 95% CI: 3.3, 5.2) and firearm suicide (ccOR of 2.2; 95% CI: 1.7, 2.9). Similarly, having any substance use disorder was also associated with increased odds of firearm and non-firearm suicide (Table 2). For all specific diagnoses explored in this analysis, beneficiaries with the diagnosis had higher odds of suicide compared to those without each diagnosis (Table 2). Schizophrenia was a possible exception to this, for the outcome of firearm suicide, where the estimate was the closest to the null (ccOR of 1.5, 95% CI: 0.7, 3.5).

For all female decedents (firearm and non-firearm), and for male decedents with non-firearm suicide, the ccORs for any of the mental health diagnoses investigated (depression, anxiety, bipolar disorder, or schizophrenia) were higher than the ccORs for male decedents of firearm suicide. For example, the odds of firearm suicide among men diagnosed with depression was 1.8 (95% CI: 1.2, 2.5) times the odds of men not diagnosed with depression; however, for non-firearm suicide this ccOR was 4.3 (95% CI: 3.2, 5.8). In women, this association was 3.8 (95% CI: 2.8, 5.1) for non-firearm suicide and 3.5 (95% CI: 2.0, 5.9) for firearm suicide. We also consistently observed this pattern of attenuated ccORs for male firearm suicide for substance use disorder diagnoses. The association of alcohol use disorder with non-firearm suicide in men (ccOR of 3.3; 95% CI: 2.3, 4.8) was still higher than that of firearm suicide (ccOR of 2.6; 95% CI: 1.6, 4.1), but firearm and non-firearm ccORs were closer than seen in other behavioral diagnoses among men (Table 2). In contrast, associations for the diagnosis of fibromyalgia, chronic pain, or sleep disorders and epilepsy did not differ substantially by method among males or females (Table 2). We also did not observe evidence of a difference in association by method for the diagnosis of TBI, either, but this low-prevalence diagnosis had imprecise estimates in both sexes (Table 2).

Firearm means was proportionally less prevalent in suicides among Blacks (n=20; 22%) compared to non-Blacks (n=235; 39) (Figure 3). Among non-Blacks, we observed a pattern similar to that in the unstratified (Blacks and non-Blacks combined) results, where the associations between behavioral health diagnoses and firearm suicide are generally weaker than those of diagnoses with non-firearm suicide (Table 3). Among Black decedents, similar

but attenuated associations were observed. However, results for Black decedents should be interpreted with caution because the estimates were imprecise, particularly for firearm deaths (Table 3). Stratifying exposure to any mental health disorder by sex and race further suggested that this pattern of stronger associations for non-firearm suicide was present for both Black and non-Black men. In women, across all four combinations of race and means, the ccORs were similar (Table 4).

In sensitivity analyses, models with different levels of matching and restrictions did not substantively change our findings, and the adjustment variables tended to have the greatest impact on the associations in the strata of non-firearm suicide in women. For example, among women with a diagnosis of any mental health disorder, the unadjusted estimate that was unmatched on coverage duration and included beneficiaries with any six of the past 12 months covered prior to the index date was 7.0 (95% CI: 5.4, 9.1) for non-firearm suicide and 6.0 (95% CI: 3.7, 9.7) for firearm suicide. The estimate for non-firearm suicide was more sensitive to the fully-adjusted, matched model that was restricted to beneficiaries with 12 months of continuous coverage (ccOR of 3.6; 95% CI: 3.0, 4.9) compared to firearm suicide (ccOR of 4.4; 95% CI: 2.5, 7.9). Including age and race in the model was responsible for the bulk of this change, reflecting the higher proportion of female Black suicide decedents in the non-firearm means category. Restricting the sample from people with any 6 of the previous 12 months covered to those with 12 months of continuous coverage excluded n=95 suicide cases and 9,918 controls. Sensitivity analyses conducted by excluding undetermined intent cases found no substantive effects on the associations of mental health and substance use disorders with suicides. Sensitivity analyses that used quantitative bias analyses of the impact of a strong confounder on the depression–suicide association in men illustrated that even as the association is attenuated by the confounder, the finding that the association with non-firearm suicide is stronger than firearm suicide is maintained (eFigure 1).

Discussion

This study identified multiple diagnostic conditions that were associated with suicide in a large Medicaid beneficiary population. Among men, behavioral diagnoses were more strongly associated with non-firearm suicide than with firearm suicide. For men with any mental health disorder or any substance use disorder diagnosis, the odds of non-firearm suicide were approximately six times the odds of men without these diagnoses. In comparison, the diagnosis of any mental health disorder among men only doubled the estimated odds of firearm suicide, and a diagnosis of any substance use disorder increased firearm suicide odds by about 3.5 times. Among women, in contrast to men, the strength of diagnoses' association with suicide was similar for both non-firearm suicide and firearm suicide. For women with any mental health diagnosis or any substance use diagnosis, the odds of suicide were about five to six times higher, regardless of the type of lethal means used (firearm and non-firearm). The estimates for male non-firearm suicide were similar to estimates for female suicide (firearm or non-firearm). One caveat for comparing these estimates is that the ccORs for female firearm suicide were less precise because the proportion of decedents who use firearms for suicide is lower in women than men.

Disaggregating the results by race suggested that the pattern of stronger behavioral health associations with non-firearm suicide was applicable to both Black and non-Black men, while the strength of these associations may be similar in women across categories of race and lethal means. However, due to the small numbers of suicide outcomes in the Black NC Medicaid population, results were imprecise and should be interpreted with caution. Prior studies have shown that minorities, especially Blacks, are less likely to be diagnosed with behavioral health conditions.[30–32] This potential undermeasurement of exposure may underlie our finding that behavioral health diagnoses' associations with suicide, regardless of means, appeared to be stronger in the non-Black population than the Black population.

Our findings complement and extend those from a previous large study of a predominantly privately insured population drawn from eight health systems across the U.S.[20] That prior study, which did not stratify specific diagnoses by sex or race, was the first to report that mental health diagnoses' associations with non-firearm suicide were larger than their associations with firearm suicide. Our study contributes new information by stratifying by sex and race, and by estimating associations among Medicaid beneficiaries, a population with a high prevalence of these conditions. This is the first study to report that the pattern of weaker associations between behavioral health diagnoses and firearm suicide was limited to male beneficiaries, and similar behavioral health diagnosis associations with both non-firearm and firearm suicide for female beneficiaries.

These findings have important implications for suicide prevention. The group that contributes the highest number of suicide deaths in this country are men who use firearms to self-inflict lethal injury, and this same group is the least diagnostically identifiable, according to these findings. However, consistent with prior research, health care utilization among suicide decedents was found to be high.[40] Although health care utilization was lower for men, most (75% of male non-firearm suicide decedents and 62% of male firearm suicide decedents) had at least one outpatient or inpatient health care system encounter in the 90 days prior to death. This indicates that opportunities for intervention are present. The finding that men at risk of firearm suicide are less likely to have a behavioral health diagnosis may reflect differences in the nature of healthcare encounters in this group. Future studies should examine the type of healthcare encounters that are most proximal to firearm suicide, and whether such healthcare encounters can be optimized to implement suicide screening and interventions for suicide prevention.

This study has several strengths. The linkage of NC Medicaid and NC-VDRS is novel, combines high-quality data on suicide with a large administrative healthcare database, and has potential for replication in other states.[8] Furthermore, understanding suicide predictors in a Medicaid population is important because this population demonstrates higher rates of suicide risk factors. This study also had some limitations. We were required to use deterministic, exact matches based on name, sex, and date of birth between NC Medicaid and NC-VDRS, which may have caused misclassification of the suicide outcome. We considered it to be reassuring that 91.5% of the members linked from NC Medicaid to NC-VDRS were recorded as deceased in the Medicaid member files, and in those cases, the death month and year matched the date recorded in NC-VDRS. Among the members who linked that were not known to be deceased by Medicaid, none had claims filed after the date

of death in NC-VDRS. Any study of suicide also faces the potential for misclassification of the outcome because suicide is sometimes not clearly discernible from other types of violent death. In view of this, we included deaths due to undetermined intent in our outcome (8% of cases) and conducted sensitivity analyses which showed robust results after exclusion of undetermined intent cases.

Another limitation is that known suicide risk factors such as proximal stressful life events (including pregnancy), adverse childhood experiences, sexual orientation, personality traits, urban vs. rural status, and employment were not available in this study. Also, as explained previously, not controlling for confounding in the presence of multiple behavior health diagnosis is another limitation. We used quantitative bias analysis to illustrate that the study findings were robust even to strong confounding. Members of this cohort may also have had diagnoses that were not associated with a Medicaid claim, either because they were not covered by Medicaid at the time or because a claim was not filed, or because the chronic conditions algorithm did not detect the claim, as has been shown to happen.[41] This could lead to underestimation of diagnosed behavioral health conditions. We attempted to limit this potential bias by requiring cases and controls to be covered by Medicaid for 12 continuous months prior to the index date and by matching on coverage duration over the past 36 months. This choice may have limited the generalizability of our findings because of turnover in the Medicaid-covered population. Sensitivity analyses that required beneficiaries to be insured only for any 6 of the past 12 months generated substantively similar results (eTable 1).

Conclusions

Identifying patients at risk of suicide in the health care system is important for targeting prevention efforts. Prior research has suggested that diagnostic risk factors, such as behavioral health diagnoses, are more strongly associated with non-firearm suicide than with firearm suicide. Our results in a Medicaid population showed that this discrepancy was limited to men. Women at risk of firearm suicide may be more easily identified than men using behavioral health diagnoses.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments:

References

1. Hedegaard H, Curtin SC, Warner M. Increase in suicide mortality in the United States, 1999–2018. National Center for Health Statistics Data Brief number 362. Washington (DC), 2020.

2. Sher L The impact of the COVID-19 pandemic on suicide rates. QJM: An International Journal of Medicine 2020;113(10):707–712. [PubMed: 32539153]

3. Ajdacic-Gross V, Weiss MG, Ring M, Hepp U, Bopp M, Gutzwiller F, Rössler W. Methods of suicide: international suicide patterns derived from the WHO mortality database. Bulletin of the World Health Organization 2008;86:726–732. [PubMed: 18797649]

4. Stone DM, Simon TR, Fowler KA, Kegler SR, Yuan K, Holland KM, Ivey-Stephenson AZ, Crosby AE. Vital signs: trends in state suicide rates—United States, 1999–2016 and circumstances contributing to suicide—27 states, 2015. Morbidity and Mortality Weekly Report 2018;67(22):617. [PubMed: 29879094]

5. Naghavi M, Marczak LB, Kutz M, et al. Global mortality from firearms, 1990-2016. Jama 2018;320(8):792–814. [PubMed: 30167700]

6. Labouliere CD, Vasan P, Kramer A, Brown G, Green K, Rahman M, Kammer J, Finnerty M, Stanley B. "Zero Suicide"–A model for reducing suicide in United States behavioral healthcare. Suicidologi 2018;23(1):22. [PubMed: 29970972]

7. 2012 National Strategy for Suicide Prevention: Goals and Objectives for Action: A Report of the U.S. Surgeon General and of the National Action Alliance for Suicide Prevention. Publications and Reports of the Surgeon General. Washington (DC), 2012.

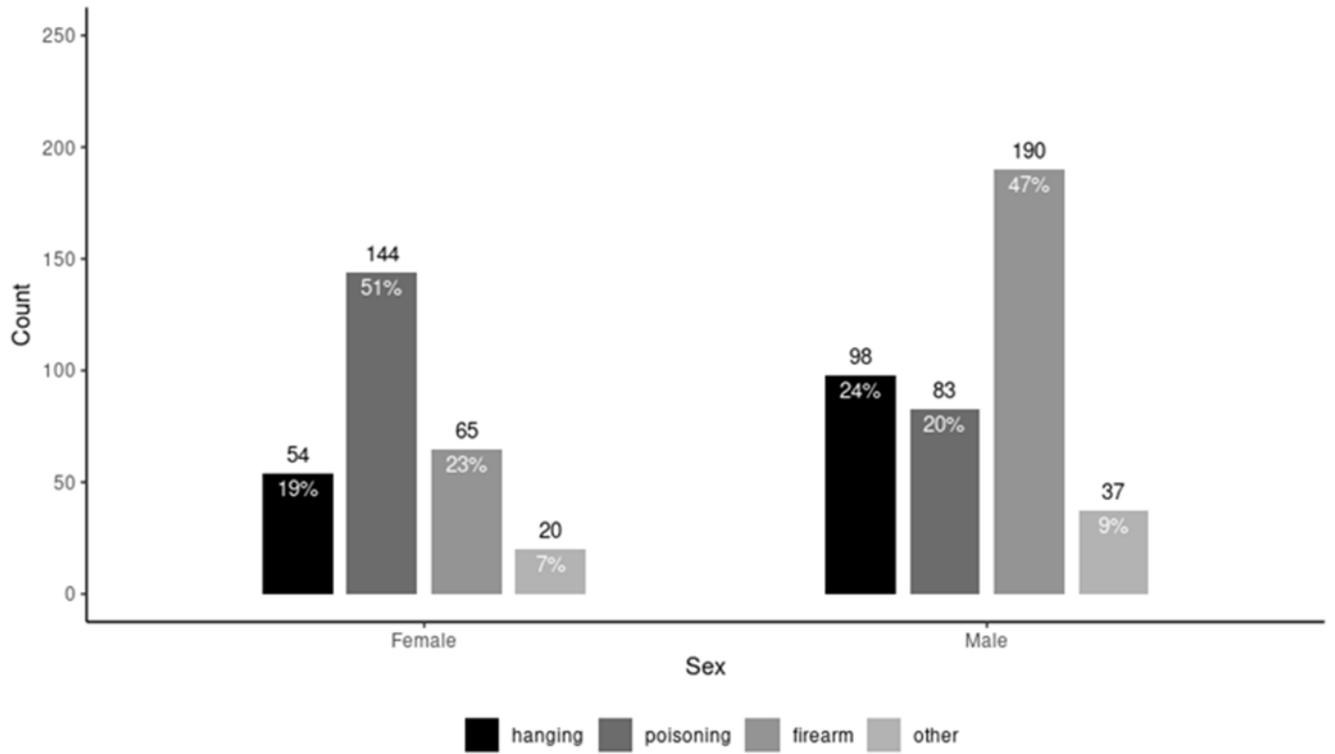8. Sivaraman JJC, Naumann RB. Estimating the Association Between Mental Health Disorders and Suicide: a Review of Common Sources of Bias and Challenges and Opportunities for US-Based Research. Current Epidemiology Reports 2020:1–11.

9. Too LS, Spittal MJ, Bugeja L, Reifels L, Butterworth P, Pirkis J. The association between mental disorders and suicide: A systematic review and meta-analysis of record linkage studies. J Affect Disord 2019;259:302–313. [PubMed: 31450139]

10. Mortensen PB, Agerbo E, Erikson T, Qin P, Westergaard-Nielsen N. Psychiatric illness and risk factors for suicide in Denmark. Lancet 2000;355(9197):9–12. [PubMed: 10615884]

11. Bohnert KM, Ilgen MA, Louzon S, McCarthy JF, Katz IR. Substance use disorders and the risk of suicide mortality among men and women in the US Veterans Health Administration. Addiction 2017;112(7):1193–1201. [PubMed: 28301070]

12. Conner KR, Bohnert AS, McCarthy JF, Valenstein M, Bossarte R, Ignacio R, Lu N, Ilgen MA. Mental disorder comorbidity and suicide among 2.96 million men receiving care in the Veterans Health Administration health system. J Abnorm Psychol 2013;122(1):256–63. [PubMed: 23088376]

13. Ilgen MA, Bohnert AS, Ignacio RV, McCarthy JF, Valenstein MM, Kim HM, Blow FC. Psychiatric diagnoses and risk of suicide in veterans. Archives of general psychiatry 2010;67(11):1152–1158. [PubMed: 21041616]

14. Kessler RC, Stein MB, Petukhova MV, et al. Predicting suicides after outpatient mental health visits in the Army Study to Assess Risk and Resilience in Servicemembers (Army STARRS). Mol Psychiatry 2017;22(4):544–551. [PubMed: 27431294]

15. Kessler RC, Warner CH, Ivany C, et al. Predicting suicides after psychiatric hospitalization in US Army soldiers: the Army Study To Assess Risk and rEsilience in Servicemembers (Army STARRS). JAMA Psychiatry 2015;72(1):49–57. [PubMed: 25390793]

16. Elnour AA, Harrison J. Lethality of suicide methods. Injury Prevention 2008;14(1):39–45. [PubMed: 18245314]

17. Owens D, Horrocks J, House A. Fatal and non-fatal repetition of self-harm: systematic review. The British Journal of Psychiatry 2002;181(3):193–199. [PubMed: 12204922]

18. Sale E, Hendricks M, Weil V, Miller C, Perkins S, McCudden S. Counseling on Access to Lethal Means (CALM): an evaluation of a suicide prevention means restriction training program

for mental health providers. Community mental health journal 2018;54(3):293–301. [PubMed: 29185154]

19. Lubin G, Werbeloff N, Halperin D, Shmushkevitch M, Weiser M, Knobler HY. Decrease in suicide rates after a change of policy reducing access to firearms in adolescents: a naturalistic epidemiological study. Suicide and Life-threatening behavior 2010;40(5):421–424. [PubMed: 21034205]

20. Boggs JM, Beck A, Hubley S, et al. General Medical, Mental Health, and Demographic Risk Factors Associated With Suicide by Firearm Compared With Other Means. Psychiatr Serv 2018;69(6):677–684. [PubMed: 29446332]

21. Chang T, Davis M. Potential adult Medicaid beneficiaries under the Patient Protection and Affordable Care Act compared with current adult Medicaid beneficiaries. Ann Fam Med 2013;11(5):406–11. [PubMed: 24019271]

22. Decker SL, Kostova D, Kenney GM, Long SK. Health status, risk factors, and medical conditions among persons enrolled in Medicaid vs uninsured low-income adults potentially eligible for Medicaid under the Affordable Care Act. JAMA 2013;309(24):2579–86. [PubMed: 23793267]

23. Peterson C, Xu L, Mikosz CA, Florence C, Mack KA. US hospital discharges documenting patient opioid use disorder without opioid overdose or treatment services, 2011–2015. Journal of substance abuse treatment 2018;92:35–39. [PubMed: 30032942]

24. Thomas MR, Waxmonsky JA, Gabow PA, Flanders-McGinnis G, Socherman R, Rost K. Prevalence of psychiatric disorders and costs of care among adult enrollees in a Medicaid HMO. Psychiatr Serv 2005;56(11):1394–401. [PubMed: 16282258]

25. Tsirigotis K, Gruszczynski W, Tsirigotis M. Gender differentiation in methods of suicide attempts. Med Sci Monit 2011;17(8):PH65–70. [PubMed: 21804473]

26. Spicer RS, Miller TR. Suicide acts in 8 states: incidence and case fatality rates by demographics and method. American journal of public health 2000;90(12):1885. [PubMed: 11111261]

27. Chronic Conditions Data Warehouse. https://www2.ccwdata.org/web/guest/condition-categories Accessed May 6, 2020.

28. Robins JM, Gail MH, Lubin JH. More on" Biased selection of controls for case–control analyses of cohort studies". Biometrics 1986:293–299. [PubMed: 3741971]

29. National Violent Death Reporting System (NVDRS) Coding Manual Revised 2018 National Center for Injury Prevention and Control. In: Prevention CfDCa, ed Centers for Disease Control and Prevention.

30. Shao Z, Richie WD, Bailey RK. Racial and ethnic disparity in major depressive disorder. Journal of racial and ethnic health disparities 2016;3(4):692–705. [PubMed: 27294764]

31. Snowden LR. Bias in mental health assessment and intervention: Theory and evidence. American Journal of Public Health 2003;93(2):239–243. [PubMed: 12554576]

32. Lewis TT, Cogburn CD, Williams DR. Self-reported experiences of discrimination and health: scientific advances, ongoing controversies, and emerging issues. Annual review of clinical psychology 2015;11:407–440.

33. Hedegaard H, Curtin SC, Warner M. Suicide Mortality in the United States, 1999-2017. NCHS Data Brief 2018(330):1–8.

34. Quan H, Sundararajan V, Halfon P, et al. Coding algorithms for defining comorbidities in ICD-9-CM and ICD-10 administrative data. Medical care 2005:1130–1139. [PubMed: 16224307]

35. Poole C Low P-values or narrow confidence intervals: which are more durable? Epidemiology 2001;12(3):291–294. [PubMed: 11337599]

36. Olfson M, Wall M, Wang S, Crystal S, Bridge JA, Liu SM, Blanco C. Suicide After Deliberate Self-Harm in Adolescents and Young Adults. Pediatrics 2018;141(4).

37. Olfson M, Wall M, Wang S, Crystal S, Liu SM, Gerhard T, Blanco C. Short-term Suicide Risk After Psychiatric Hospital Discharge. JAMA Psychiatry 2016;73(11):1119–1126. [PubMed: 27654151]

38. Lash TL, Fox MP, Fink AK. Applying quantitative bias analysis to epidemiologic data Springer Science & Business Media, 2011.

39. Sivaraman J The association between substance use disorders and suicide in North Carolina claims data. https://osf.io/sxefr/?view_only=c57460241ca242388a0666b828381e80 Accessed May 20, 2021.

40. Ahmedani BK, Westphal J, Autio K, et al. Variation in patterns of health care before suicide: A population case–control study. Prev Med 2019;127:105796. [PubMed: 31400374]

41. St Clair P, Gaudette E, Zhao H, Tysinger B, Seyedin R, Goldman DP. Using Self-reports or Claims to Assess Disease Prevalence: It's Complicated. Med Care 2017;55(8):782–788. [PubMed: 28617703]

NC Medicaid   **NC-VDRS**

1,361 linked cases
Suicide/undetermined intent
2014-2017

Excluded 670 cases:
- >=10 years   (11 cases)
- Covered 12 continuous
  months immediately prior to
  index month (657 cases)
- Coverage for severe mental
  disability excluded (2 cases)

68,682 controls
(66,946 unique individuals)

691 cases

Containing:
- 57 (8%) undetermined intent
- 255 (33%) firearm deaths
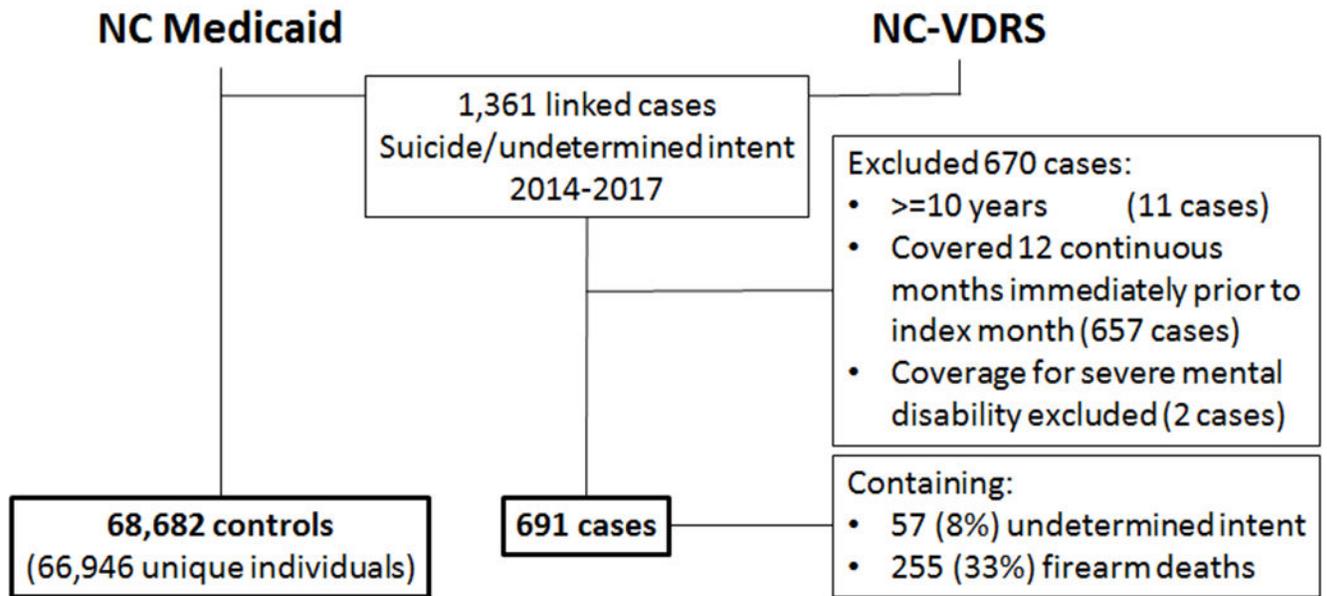
Figure 1:
Flow chart for study sample.

Figure 2:
Suicide method by sex, North Carolina Medicaid beneficiaries, 2014-2017.
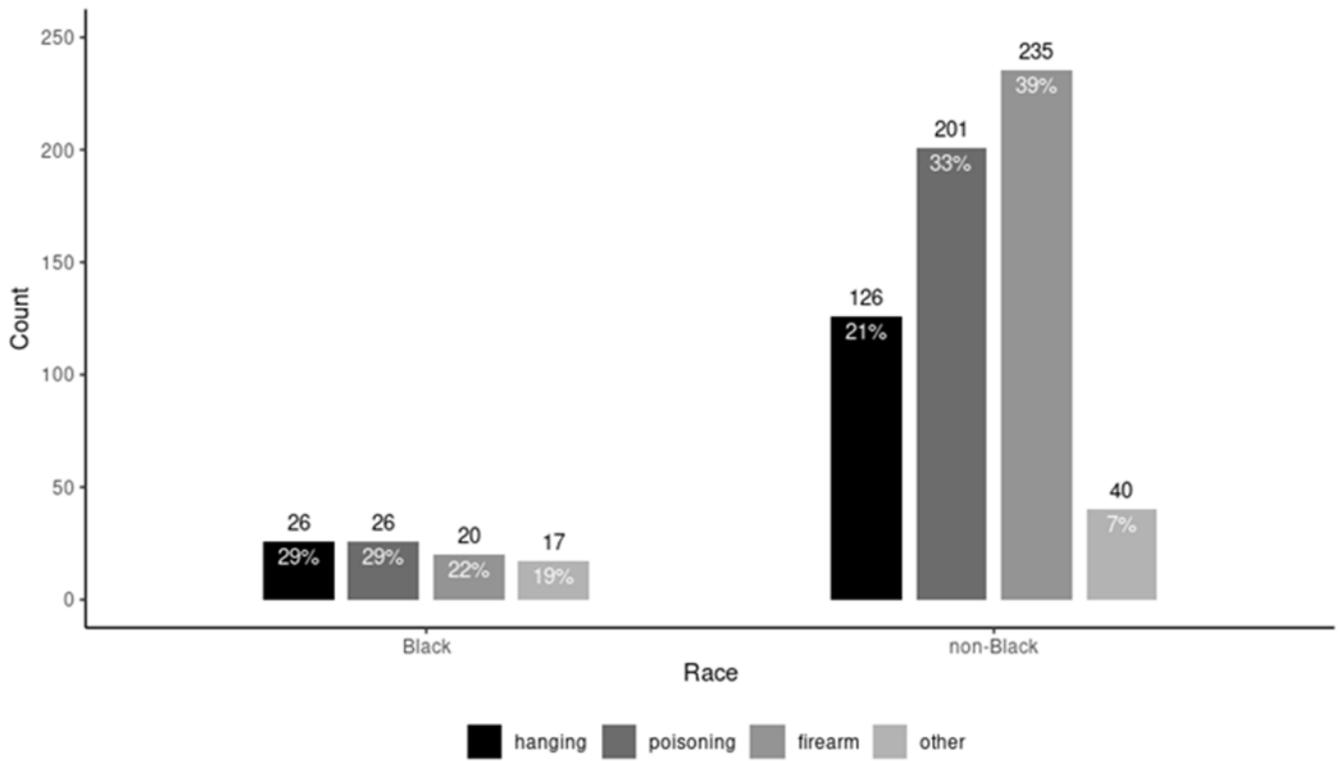
Figure 3:
Suicide method by race, North Carolina Medicaid beneficiaries, 2014-2017.

Table 1.

Demographics, diagnoses, and healthcare utilization, by gender, in a cohort of North Carolina Medicaid beneficiaries, 2014–2017.

	Female (n=42,171)				Male (n=27,202)			
	All cases (n=283)	Firearm cases (n=65)	Non-Firearm cases (n=218)	Controls (n=41,888)	All cases (n=408)	Firearm cases (n=190)	Non-Firearm cases (n=218)	Controls (n=26,794)
Age (med, IQR)	42 (31, 54)	37 (28, 52)	44 (33, 54)	30 (17, 53)	46 (29, 58)	52 (34, 64)	41 (27, 54)	19 (14, 50)
Race (n, %)								
Black	34 (12.0)	10	30 (13.8)	17,311 (41.3)	55 (13.5)	16 (8.4)	39 (17.9)	10,841 (40.5)
White	240 (84.8)	59 (90.8)	181 (83.0)	22,572 (53.9)	332 (81.4)	163 (85.8)	169 (77.5)	14,526 (54.2)
Other	10	10	10	1,512 (3.6)	12 (2.9)	10	10	993 (3.7)
Unreported	10	10	10	488 (1.2)	10	10	10	434 (1.6)
SSI (n, %)								
Yes	78 (27.6)	13 (20.0)	65 (29.8)	7,266 (17.4)	138 (33.8)	48 (25.3)	90 (41.3)	6,183 (23.1)
No	205 (72.4)	52 (80.0)	153 (70.2)	34,617 (82.7)	270 (66.2)	142 (74.8)	128 (58.7)	20,611 (76.9)
Medicaid benefit plan category (n, %)								
Family Planning	21 (7.4)	10	NR	3,697 (8.8)	19 (4.7)	NR	10	1,134 (4.2)
Behavioral Health Services	223 (78.8)	50 (76.9)	173 (79.4)	33,920 (81.0)	323 (79.2)	138 (72.6)	185 (84.9)	22,336 (83.4)
Medicare-Aid	38 (13.4)	10	NR	2,505 (6.0)	56 (13.7)	37 (19.5)	19 (8.7)	1,572 (5.9)
North Carolina Health Choice	10	10	10	1,564 (3.7)	10	10	10	1,576 (5.9)
General Medicaid	10	10	10	202 (0.5)	10	10	10	176 (0.7)
Months covered prior to index (med, IQR)	31 (21, 36)	30 (20, 36)	31 (21, 36)	30 (20, 36)	31 (21, 36)	31 (19, 36)	32 (22, 36)	30 (20, 36)
Encounters past 90 days (med, IQR)	4 (0, 10)	3 (1, 8)	4 (0, 10)	1 (0, 3)	2 (0, 7)	1 (0, 7)	3 (1, 7)	1 (0, 3)
Behavioral health diagnoses (n, %)								
Depression	160 (56.5)	34 (52.3)	126 (57.8)	6,951 (16.6)	140 (34.3)	46 (24.2)	94 (43.1)	2,431 (9.1)
Anxiety[a]	140 (49.5)	29 (44.6)	111 (50.9)	6,068 (14.5)	138 (33.8)	52 (27.4)	86 (39.5)	2,191 (8.2)
PTSD	47 (16.6)	11 (16.9)	36 (16.5)	1,098 (2.6)	25 (6.1)	10	NR	411 (1.5)
Bipolar	85 (30.0)	14 (21.5)	71 (32.6)	2,246 (5.4)	64 (15.7)	16 (8.4)	48 (22.0)	1,213 (4.5)
Schizophrenia	22 (7.8)	10	NR	267 (0.6)	24 (5.9)	10	NR	298 (1.1)
AUD	30 (10.6)	10	NR	593 (1.4)	63 (15.4)	24 (12.6)	39 (17.9)	877 (3.3)

	Female (n=42,171)				Male (n=27,202)			
	All cases (n=283)	Firearm cases (n=65)	Non-Firearm cases (n=218)	Controls (n=41,888)	All cases (n=408)	Firearm cases (n=190)	Non-Firearm cases (n=218)	Controls (n=26,794)
DUD	57 (20.1)	13 (20.0)	44 (20.2)	1,740 (4.2)	82 (20.1)	25 (13.2)	57 (26.2)	1,120 (4.2)
OUD	42 (14.8)	10	NR	601 (1.4)	37 (9.1)	10	NR	241 (0.9)
Other health diagnoses (n, %)								
TBI	10	10	10	94 (0.2)	10	10	10	103 (0.4)
Epilepsy	38 (13.4)	10	NR	958 (2.3)	27 (6.6)	12 (6.3)	15 (6.9)	771 (2.9)
Fibromyalgia, Pain, Fatigue	104 (36.8)	24 (36.9)	80 (36.7)	4,691 (11.2)	123 (30.2)	51 (26.8)	72 (33.0)	2,022 (7.6)
CCI (med, IQR)	1 (0, 3)	1 (0, 2)	1 (0, 3)	0 (0, 1)	1 (0, 2)	1 (0, 2)	0.5 (0, 2)	0 (0, 1)
Self-injurious diagnoses (n, %)								
Suicide Ideation	16 (5.6)	10	NR	135 (0.3)	23 (5.6)	10	NR	91 (0.3)
Self-harm/suicide attempt	30 (10.6)	10	NR	77 (0.2)	44 (10.8)	11 (5.8)	33 (15.1)	33 (0.1)

med=median; IQR=interquartile range; NR=Not reported because doing so could make ≤10 cells identifiable; SSI=Supplemental Security Income; PTSD=post-traumatic stress disorder; AUD=alcohol use disorder; DUD=drug use disorder; OUD=opioid use disorder; TBI=traumatic brain injury; CCI=charlson comorbidity index;

[a] PTSD diagnoses not included

Table 2.

Association between diagnoses and suicide by method among North Carolina Medicaid beneficiaries[a], 2014-2017, by sex.

Diagnosis	Women		Men		Overall (male and female combined)	
	non-Firearm (n=218 cases)	Firearm (n=65 cases)	non-Firearm (n=218 cases)	Firearm (n=190 cases)	non-Firearm (n=436 cases)	Firearm (n=255 cases)
	ccOR (95% CI); CLR	ccOR (95% CI); CLR	ccOR (95% CI); CLR	ccOR (95% CI); CLR	ccOR (95% CI); CLR	ccOR (95% CI); CLR
Behavioral						
Depression	3.8 (2.8, 5.1); 2	3.5 (2.0, 5.9); 3	4.3 (3.2, 5.8); 2	1.8 (1.2, 2.5); 2	4.0 (3.3, 5.0); 2	2.1 (1.6, 2.9); 2
Anxiety	3.0 (2.2, 4.0); 2	2.6 (1.4, 4.5); 3	3.6 (2.6, 4.9); 2	2.1 (1.5, 3.0); 2	3.3 (2.7, 4.1); 2	2.2 (1.7, 2.9); 2
PTSD	3.9 (2.6, 5.7); 2	4.7 (2.4, 9.3); 4	4.2 (2.6, 6.7); 3	1.2 (0.4, 3.3); 8	4.0 (3.0, 5.4); 2	2.7 (1.6, 4.7); 2
Bipolar Disorder	4.3 (3.1, 5.8); 2	2.6 (1.4, 4.9); 4	3.3 (2.4, 4.7); 2	1.4 (0.8, 2.3); 3	3.8 (3.1, 4.8); 2	1.8 (1.2, 2.6); 2
Schizophrenia	8.3 (5.0, 14.0); 3	5.8 (1.7, 19.4); 11	4.6 (2.8, 7.5); 3	0.9 (0.3, 2.9);	6.0 (4.2, 8.6); 2	1.5 (0.7, 3.5); 5
Any mental health disorder	3.6 (3.0, 4.9); 2	4.4 (2.5, 7.9); 3	4.7 (3.5, 6.4); 2	1.8 (1.3, 2.4)	4.2 (3.3, 5.2); 2	2.2 (1.7, 2.9); 2
AUD	4.6 (3.0, 7.1); 2	2.7 (1.0, 7.1); 7	3.3 (2.3, 4.8); 2	2.6 (1.6, 4.1)	3.6 (2.7, 4.8); 2	2.6 (1.7, 3.9); 2
DUD	3.0 (2.1, 4.2); 2	3.1 (1.6, 6.1); 4	4.4 (3.2, 6.2); 2	2.7 (1.7, 4.2)	3.6 (2.8, 4.6); 2	2.9 (2.0, 4.1); 2
OUD	5.0 (3.3, 7.4); 2	4.4 (2.1, 9.3); 4	5.7 (3.7, 9.0); 2	2.7 (1.4, 5.3)	5.2 (3.9, 7.1); 2	3.3 (2.1, 5.6); 2
Any substance use disorder	3.5 (2.5, 4.8); 2	4.0 (2.2, 7.1); 3	4.3 (3.2, 5.9); 2	2.7 (1.9, 3.9)	3.8 (3.0, 4.7); 2	3.0 (2.2, 4.2); 2
Other						
Epilepsy	3.9 (2.6, 5.9); 2	2.8 (1.2, 6.7); 6	1.3 (0.7, 2.1); 3	1.5 (0.8, 2.7)	2.4 (1.7, 3.2); 2	1.7 (1.0, 2.8); 2
TBI	4.9 (1.7, 13.7); 8	9.2 (2.2, 39.3); 18	1.9 (0.6, 6.2); 10	2.5 (0.8, 8.1)	3.0 (1.4, 6.5); 5	3.4 (1.4, 8.5); 6
Chronic pain, fibromyalgia, sleep disorders	1.9 (1.4, 2.6); 2	2.7 (1.5, 4.9); 3	2.7 (2.0, 3.8); 2	2.0 (1.4, 2.9)	2.3 (1.8, 2.8); 2	2.1 (1.6, 2.9); 2

[a]Beneficiaries with 12 months of continuous Medicaid coverage. ccOR=case-control odds ratio matched on coverage duration and adjusted for age, race, sex, SSI, CCI, coverage duration, number of visits in the past 90 days; CI=confidence interval; CLR=confidence limit ratio; PTSD=post-traumatic stress disorder; AUD=alcohol use disorder; DUD=drug use disorder; OUD=opioid use disorder; TBI=traumatic brain injury

Table 3.

Association between diagnoses and suicide by method among North Carolina Medicaid beneficiaries, 2014-2017, by race.

Diagnosis	Black		non-Black		Overall (Black and non-Black)	
	non-Firearm (n=69 cases) ccOR (95% CI); CLR	Firearm (n=20 cases) ccOR (95% CI); CLR	non-Firearm (n=367 cases) ccOR (95% CI); CLR	Firearm (n=235 cases) ccOR (95% CI); CLR	non-Firearm (n=436 cases) ccOR (95% CI); CLR	Firearm (n=255 cases) ccOR (95% CI); CLR
Behavioral						
Depression	3.6 (2.0, 6.2); 3	0.9 (0.2, 4.2); 21	4.1 (3.3, 5.2); 2	2.2 (1.6, 3.0); 2	4.0 (3.3, 5.0); 2	2.1 (1.6, 2.9); 2
Anxiety	1.8 (0.9, 3.6); 4	NR	3.5 (2.8, 4.3); 2	2.3 (1.7, 3.1); 2	3.3 (2.7, 4.1); 2	2.2 (1.7, 2.9); 2
PTSD	3.9 (1.7, 8.8); 5	NR	3.8 (2.8, 5.3); 2	2.7 (1.5, 4.8); 3	4.0 (3.0, 5.4); 2	2.7 (1.6, 4.7); 2
Bipolar Disorder	4.7 (2.5, 8.7); 3	NR	3.6 (2.8, 4.6); 2	1.9 (1.3, 2.8); 2	3.8 (3.1, 4.8); 2	1.8 (1.2, 2.6); 2
Schizophrenia	7.5 (3.4, 16.4); 5	NR	5.8 (3.9, 8.7); 2	1.7 (0.7, 3.9); 5	6.0 (4.2, 8.6); 2	1.5 (0.7, 3.5); 5
Any mental health disorder	3.8 (2.2, 6.5); 3	0.8 (0.2, 3.0); 13	4.2 (3.3, 5.4); 2	2.3 (1.7, 3.1); 2	4.2 (3.3, 5.2); 2	2.2 (1.7, 2.9); 2
AUD	3.6 (1.7, 7.5); 4	NR	3.6 (2.6, 4.9); 2	2.8 (1.8, 4.3); 2	3.6 (2.7, 4.8); 2	2.6 (1.7, 3.9); 2
DUD	2.2 (1.1, 4.4); 4	2.8 (0.8, 10.1); 13	3.9 (3.0, 5.0); 2	2.9 (2.0, 4.3); 2	3.6 (2.8, 4.6); 2	2.9 (2.0, 4.1); 2
OUD	5.6 (1.5, 17.6); 12	NR	5.2 (3.8, 7.1); 2	3.5 (2.1, 5.7); 3	5.2 (3.9, 7.1); 2	3.3 (2.1, 5.6); 2
Any substance use disorder	2.3 (1.2, 4.4); 4	1.7 (0.5, 6.3); 14	4.1 (3.2, 5.2); 2	3.2 (2.3, 4.5); 2	3.8 (3.0, 4.7); 2	3.0 (2.2, 4.2); 2
Other						
Epilepsy	1.9 (0.8, 5.0); 7	3.3 (0.7, 15.0); 21	2.5 (1.8, 3.5); 2	1.5 (0.9, 2.7); 3	2.4 (1.7, 3.2); 2	1.7 (1.0, 2.8); 2
TBI	NR	NR	3.3 (1.5, 7.2); 5	3.6 (1.4, 9.0); 6	3.0 (1.4, 6.5); 5	3.4 (1.4, 8.5); 6
Chronic pain, fibromyalgia, sleep disorders	1.5 (0.7, 3.0); 4	1.0 (0.2, 4.6); 23	2.3 (1.8, 2.9); 2	2.2 (1.6, 3.1); 2	2.3 (1.8, 2.8); 2	2.1 (1.6, 2.9); 2

ccOR=case-control odds ratio adjusted for age, race, sex, SSI, CCI, coverage duration, number of visits in the past 90 days; CI=confidence interval; CLR=confidence limit ratio; PTSD=post-traumatic stress disorder; AUD=alcohol use disorder; DUD=drug use disorder; OUD=opioid use disorder; TBI=traumatic brain injury; NR=not reported due to the low numbers of deaths.

Table 4.

Association between Medicaid diagnosis of any mental health disorder and firearm and non-firearm suicide, by strata of sex and race, North Carolina 2014-2017.

Sex	Race	Suicide Means	Number of Cases	ccOR (95% CI); CLR
Men	Black	non-Firearm	39	3.2 (1.6, 6.5); 4
		Firearm	16	NR
	non-Black	non-Firearm	174	5.3 (3.8, 7.6); 2
		Firearm	170	1.9 (1.4, 2.7); 2
Women	Black	non-Firearm	30	5.1 (2.2, 11.6); 5
		Firearm	<10	NR
	non-Black	non-Firearm	186	3.3 (2.3, 4.6); 2
		Firearm	61	4.2 (2.3, 7.7); 3

ccOR=case-control odds ratio; CI=confidence interval; CLR=confidence limit ratio; NR=not reported due to the low numbers of deaths.