

***North Carolina Firearm-Related Injury Surveillance
Through Emergency Rooms (NC-FASTER)
CDC-RFA-CE20-2005***

**ANNUAL DATA REPORT
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NC-FASTER: Firearm Injury Surveillance in North Carolina

Understanding NC Firearm Injury Data

Firearms are the 13th largest cause of death overall in the United States (US); they are the third leading cause of injury death, and account for half of all suicides and two thirds of all homicides. Firearms cost the nation more than \$45 billion in medical costs and lost productivity each year. Younger generations are disproportionately affected by firearm violence; while those under 45 account for only 10% of overall national mortality, half of all firearm deaths occur in those aged 10-44. Injury is the primary cause of death for younger generations, and firearms are second only to unintentional injury in the overall cause of death for those aged 10-34. This sets firearm injury apart from most causes of death in the US, as the impact on economic productivity and years of potential life lost is much greater than for diseases primarily affecting older generations, such as diabetes and stroke. Homicide alone, which is caused primarily by firearms, accounts for 1 out of every 20 years of potential life lost (YPLL) in the US. Furthermore, readmission and recidivism following non-fatal firearm-related injury are significant, adding nearly 10% to total direct medical costs for firearm-related injury and costing hundreds of millions of dollars. In North Carolina (NC), more than 60% of violent deaths are caused by firearms (most from suicide), and for every firearm-related death, there are more than 3 firearm-related injury visits to an emergency department (ED) in the state.

For the past 23 years, the CDC's National Center for Injury Prevention and Control, the source for the vast majority of federal funds for injury-related work, has been largely restricted from funding projects related to firearm injuries. This has left a gap in the understanding related to all aspects of firearm-related injury and death, including descriptive epidemiology that can be used to inform prevention and response efforts. Timely data regarding firearm-related injury are essential to support groups engaged in these efforts.

In 2020, NC received the first round of funding for the Firearm Injury Surveillance Through Emergency Rooms (FASTER) surveillance program - the first CDC funding dedicated to firearm injury surveillance in more than two decades. The goals of FASTER are to increase availability of timely data on firearm-related injuries treated in EDs, and disseminate findings from these ED surveillance data to key stakeholders working on firearm injury prevention and response efforts. For this program, the NC Injury and Violence Prevention Branch (IVPB) partnered with NC Division of Public Health's Epidemiology Section's Surveillance Systems Unit (SSU), the University of North Carolina (UNC) Injury Prevention Research Center (IPRC), and the Carolina Center for Health Informatics (CCHI) based in the Department of Emergency Medicine in the UNC School of Medicine. These groups have decades of experience working together to improve public health practice and surveillance in the state. Since Fall of 2020, the project team has formed an active Partners Group, developed a data dissemination plan, and evaluated both the available data and the syndromic surveillance definitions used to identify firearm-related injuries in those data.

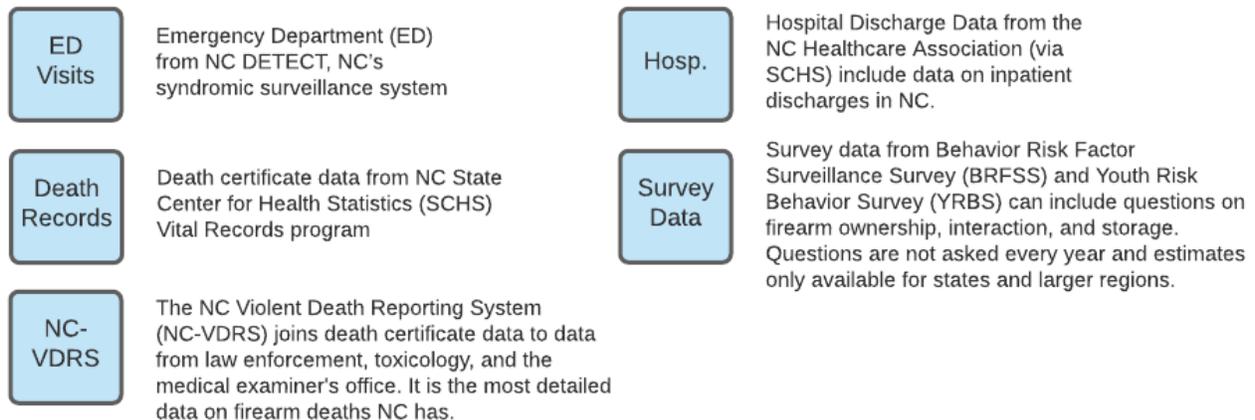
The goal of this NC-FASTER report is to provide relevant background information to Partners and collaborators regarding state data available to support firearm injury prevention efforts. In this Annual Data Report, we have included primary sources of firearm injury data from 2016 to the most recent year available to provide a brief overview of recent state trends. We also include overviews of work we are doing to address demographic and spatial patterns, disparities and special populations, and intent coding for ED visits related to firearm injury.

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NC Sources of Firearm Data

Core Data Sources

Firearm-related deaths are only the tip of the iceberg; the burden of firearm injuries can be measured by many different metrics and found in many different data sources. North Carolina has five core sources of firearm injury data: death certificates, ED visits, in-patient hospitalizations, the NC-Violent Death Reporting System (NC-VDRS), and survey data from the Behavioral Risk Factor Surveillance System (BRFSS) and the Youth Risk Behavior Survey (YRBS). Each of these data sources provide additional context on the burden of firearm-related injuries in the state as well as the prevalence of risk behaviors that can contribute to firearm-related injury.



Above: Core NC data sources for firearm data.

Novel and Supplemental Data Sources

Besides the core data sources, novel and supplemental data sources can tell us more about the events and environment that drive firearm-related injuries. Below is an incomplete list of some of those data sources:

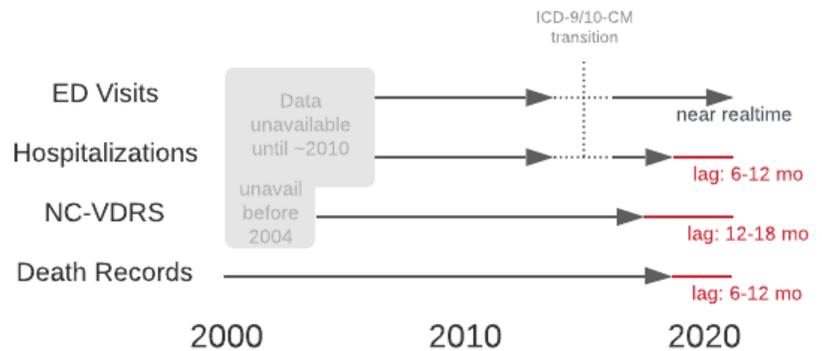
Community and violence survivor groups can share stories and wisdom about how to prevent firearm injuries. Some groups may be taking **local action for prevention** which can be tracked. **Cost Data** from tools like CDC's Web-based Injury Statistics Query and Reporting System (WISQARS), hospitalization charges, or cost-effectiveness studies of interventions can be applied to the NC environment. **Timely Incident Data** may come from law enforcement 911 or incident reports, some of which might be geocoded at the **street level**. **Spatial Data** may include firearm retailers and geocoded event data. Other health data sources, including the **NC Trauma Registry** and **Emergency Medical Services (EMS) data**, may provide details other systems miss. **Firearm-related laws** differ between states and often set the bounds on what evidence-based action is possible. Lastly, **social determinants of health and other non-medical drivers**, including demographics and disparities, also drive associations with firearm injuries and exposure to firearm violence.

Data Availability, Lag, and Suppression

Data Availability and Lag Time

Each data system has its own finalization process to ensure data quality. This impacts the timeliness and availability of annual data for firearm-related injury surveillance, as well as the availability of complete and timely provisional data. Though NC-VDRS provides the most detailed data on firearm deaths, it takes time to collect, abstract, and combine these data, and therefore has the longest lag between collection and availability for analysis (approximately 14-16 months).

NC DETECT ED visit data are the most timely data available for firearm-related injury surveillance. These data are available to NC DETECT users within the NC DETECT data portal in near real time. Clinical data (including ED and hospitalization) transitioned diagnosis and injury mechanism coding systems in 2015. Data are often suppressed for 2015 and not compared across this time frame due to this transition.

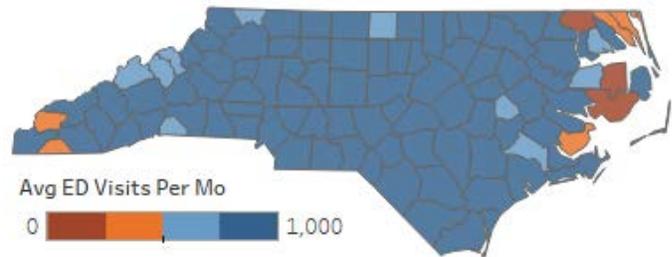


Above Right: Data lag and availability diagram for death, ED, and hospitalization data.

Data Suppression

Though ED data are available within days of a visit, ED data have strict [data suppression requirements](#) to protect patient privacy. Small counts (1-4) of visit types from time spans under 1 year cannot be reported without at least 500 total ED visits in the denominator.

Demographic-specific questions require 500 total visits by that demographic group. As illustration, 12 counties average fewer than 500 ED visits of all kinds each month. This means demographic-specific data for many groups would be suppressed for many NC counties.



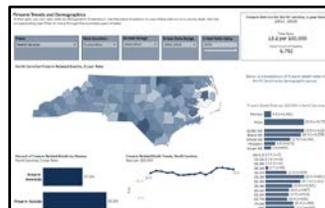
Above right: Counties with fewer than 500 ED Visits per month on average

Demographics and Disparities

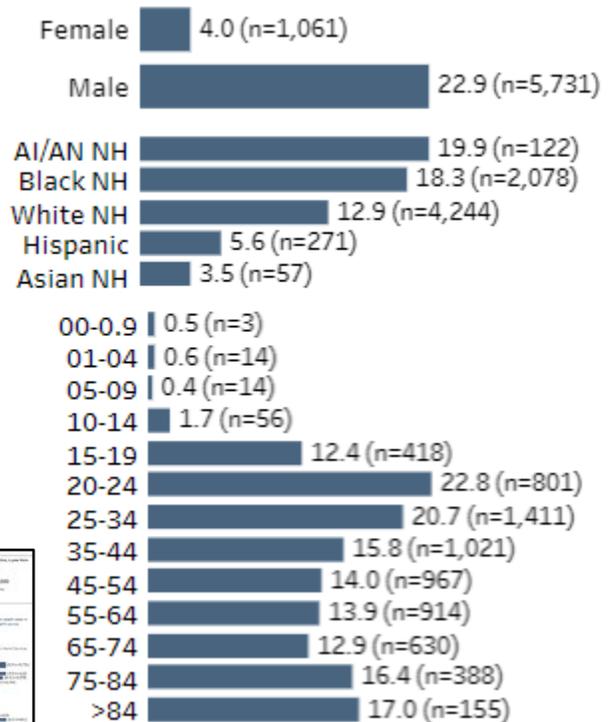
Detailed demographic data (including gender, race-ethnicity, and age groups) are important for designing interventions and understanding the disparate burden of firearm injuries. For instance, across all race-ethnicity categories, firearms deaths are more common for males than females.

However, stratified (demographic-specific) analyses trigger more strict ED data suppression rules. Moreover, once looking for demographic-specific stories by place (e.g. county) and time (e.g. month), small counts of incidents are very common, creating problems in interpreting trends, proportions, and rates. As an example, 25 counties average fewer than 500 ED visits by month and gender. Nearly all (98/100) counties average fewer than 500 ED visits by month and detailed age groups, and some age group/county combinations don't see 500 ED visits in a decade. Note also that NC residents living near the state border often travel to neighboring states for care, which further reduces resident ED visit counts.

To stabilize these demographic rates for statewide comparison, five year 2015-2019 firearm death data are presented on the [NC DPH VDRS dashboard](#) (reproduced, at right).



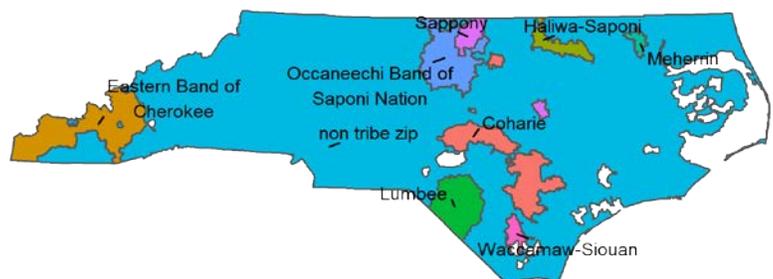
Firearm Death Rate per 100,000 in North Carolina



Indigenous, Native American, and Tribal Populations

Firearm data for indigenous, American Indian, and tribe-specific populations can be uniquely challenging for public health to provide data. First, in many counties, indigenous and tribal populations are small relative to other demographic groups, which often triggers data suppression thresholds designed to protect individual health information. Moreover, tribe-specific information is often not available in health data, making it impossible to simply tally events by those tribal affiliations.

Novel analysis approaches can help, but still require critical thinking and planning. During the COVID-19 pandemic, demographic information ("Native American") was combined with a zip code table to estimate tribal affiliation for improved communication (see map, right). If tribal data were missing in death records, similar analyses may be possible using regions of the state and last name patterns. None of these approaches are perfect, but in some cases imperfect data may be better than no data at all.

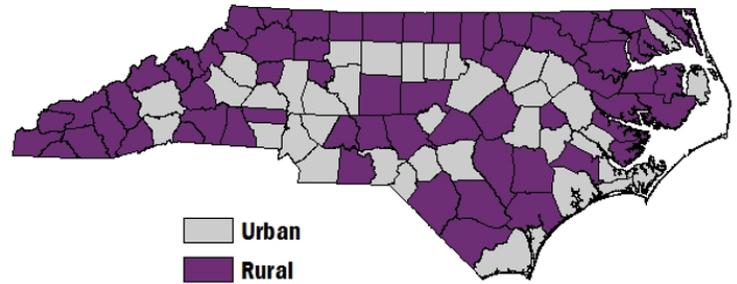


Spatial Patterns - Rural / Urban Firearm Injuries

Firearm data are available at different spatial scales. Some **event data** like gun injury incidents and deaths can be geocoded at the point-level, and spatially jittered to provide some privacy protections. **Aggregate population data** - at levels including census tract / neighborhood, zip code, city, county, and state region - are often used for population-level action and surveillance efforts. Not all small spatial scales are available in all data sources: the most granular ED data are available at the 5-digit zip code level, and survey data are often not available any smaller than regions and large counties.

NC has the second largest rural population in the country, and there was interest from partners on better understanding geographic differences in non-fatal firearm injury ED visits. An exploratory analysis was conducted to identify if there were differences in non-fatal firearm injury based on rurality using ED data.

Urban/Rural Classification of NC Counties

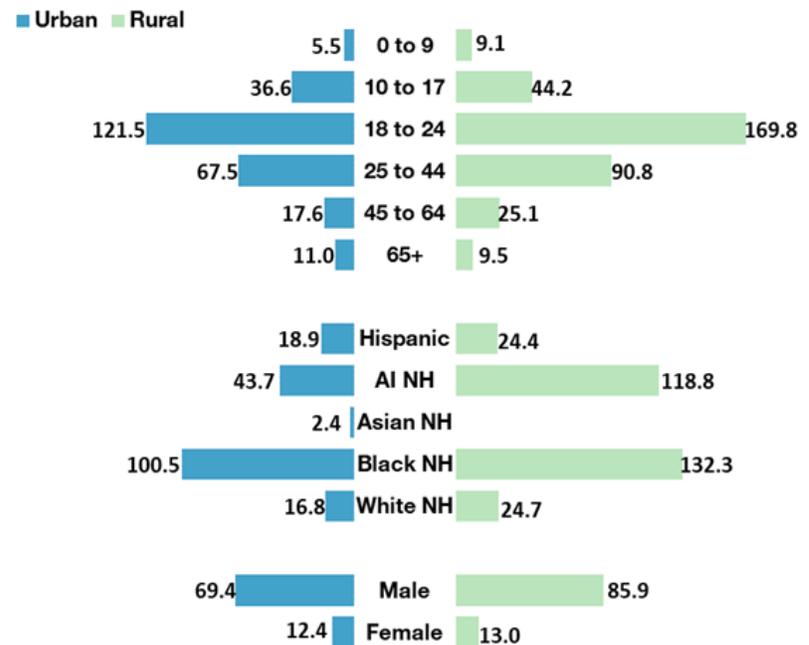


The US Census urban/rural definition (see map on right) was used to classify firearm injury ED visits by county of residence. This definition is based on residential population density, while also considering land use characteristics of densely developed territory. If 50% or more of a county's population is considered rural, then the county is classified as rural. There are rural communities located within counties that are classified as urban, as well as urban communities within counties classified as rural. However, smaller geographic areas are unavailable in the ED visit data to classify rurality at a more granular level due to privacy and data security concerns.

Statewide rates of non-fatal firearm ED visits were calculated by demographic group (age group, race/ethnicity, and sex) and urban/rural classification (figure, right). Rural rates of ED visits for non-fatal firearm injury were higher across all demographic groups other than those ages 65 and older. The greatest difference was between urban and rural NH American Indian residents, with rural NH American Indians experiencing a rate of firearm ED visits that is 2.7x higher than urban NH American Indians.

Rate of Firearm-Related ED Visits by Age Group, Race/Ethnicity, Sex, and Urban and Rural Differences

Rate per 100,000 Residents, Jan 2021 - Dec 2021

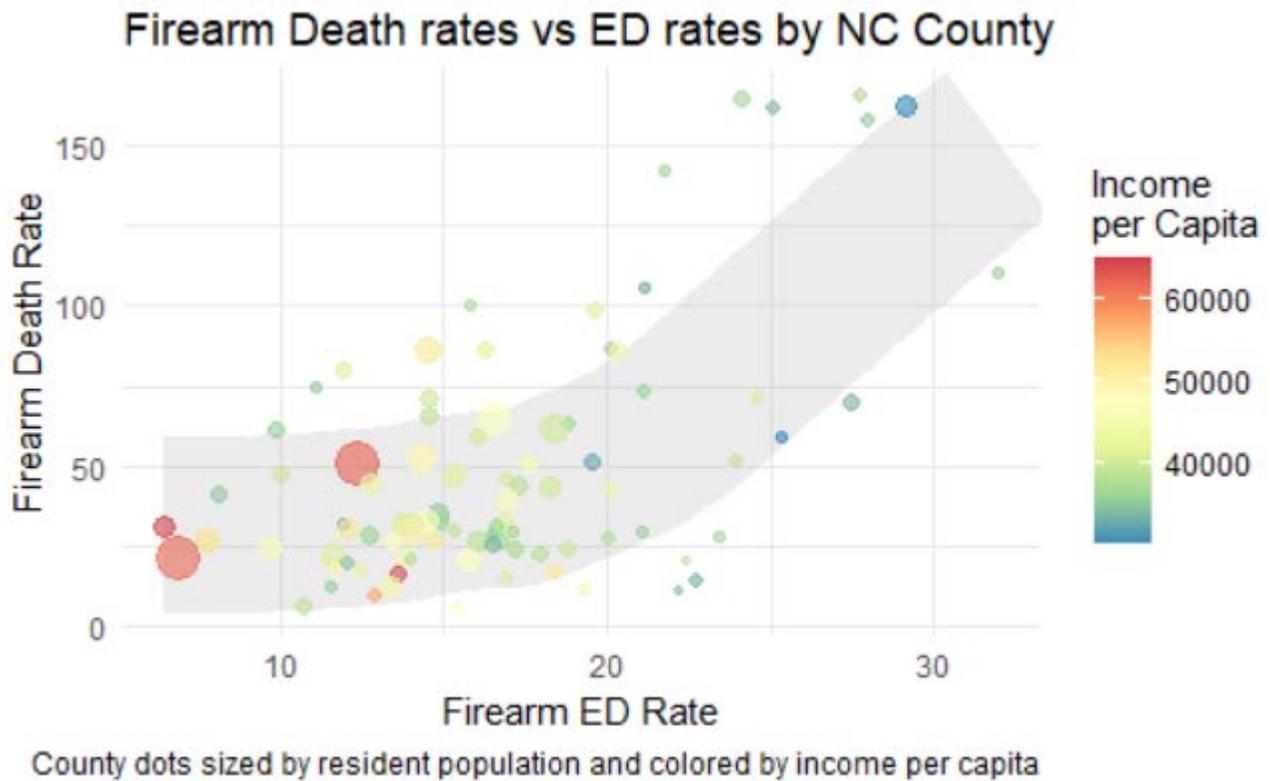


Social Determinants of Health

Krishna Dutt completed an exploratory analysis of the association of firearm ED visits and firearm deaths, examining the social determinants connected to that association. Those determinants of health include: (1) hospital bed density, (2) income per capita, (3) mental health professional shortage areas (HPSAs), (4) population size, and (5) rurality.

At the county level (NC) from 2017 through 2020, firearm injury death rates (almost) increase proportionally with firearm injury ED Visit rates. This relationship is further explained by a county's area-designation, hospital bed density, and income per capita. For example, firearm death rates modestly decrease as a county's hospital bed density increases.

Firearm injury death and ED visit rates increase significantly for NC counties designated as rural. Rural counties in NC (smaller dots / populations in graph below, typically lower income per capita) have higher death and ED rates per capita for firearm injury.

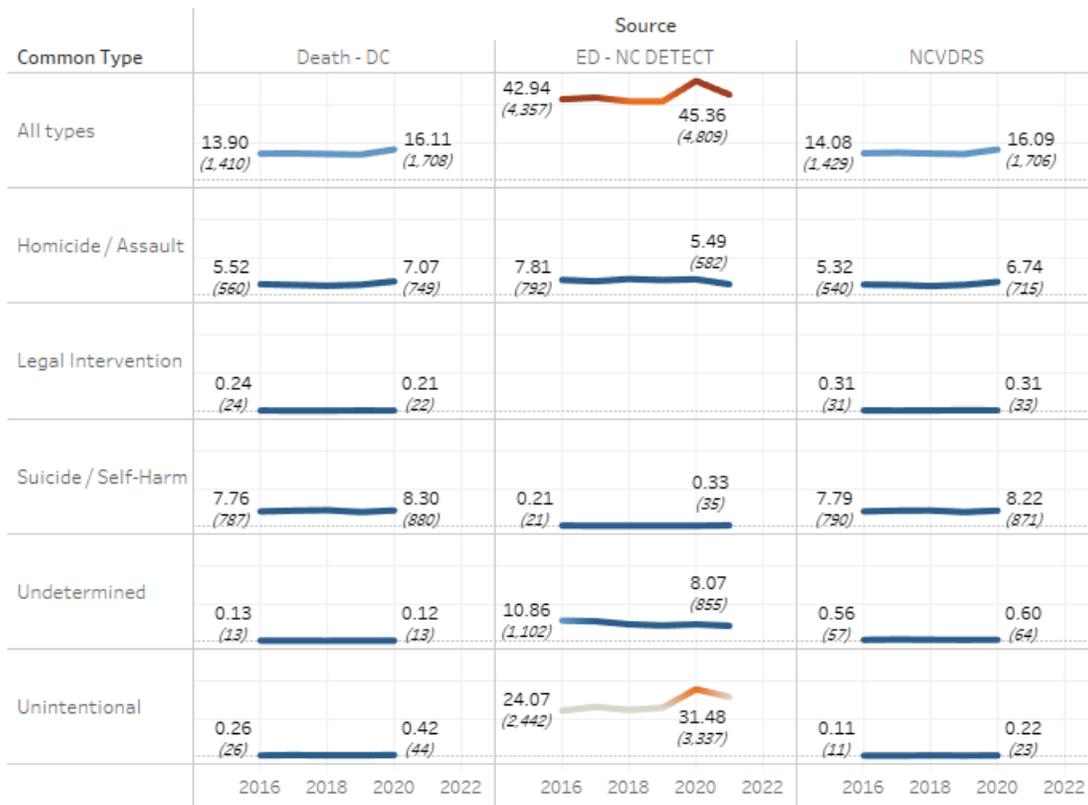


Statewide Data & Trends

The NC-FASTER team has begun to harmonize data across three initial data sources: timely ED data from NC DETECT, death certificate data, and death data from NC-VDRS. That harmonization process has already identified key lessons. First, ED visits see very high numbers of firearm injuries categorized as unintentional, which look to be a combination of actual unintentional firearm injuries and miscoded undetermined, self-harm or assault injuries. Second, we note that NC-VDRS and death certificates have very similar rates, counts, and trends, suggesting NC-VDRS is likely best used for more detailed questions, although death certificate data are usually more timely. Lastly, harmonization work is continuing; for example, NC DETECT ED data do not yet have a syndrome definition for firearm injuries from legal intervention. Below are statewide rates and counts for firearm intent groups, from 2016 through the most recent year of data available.

Rates (& Counts) of NC Firearm Injury / Death

(population rates per 100,000)



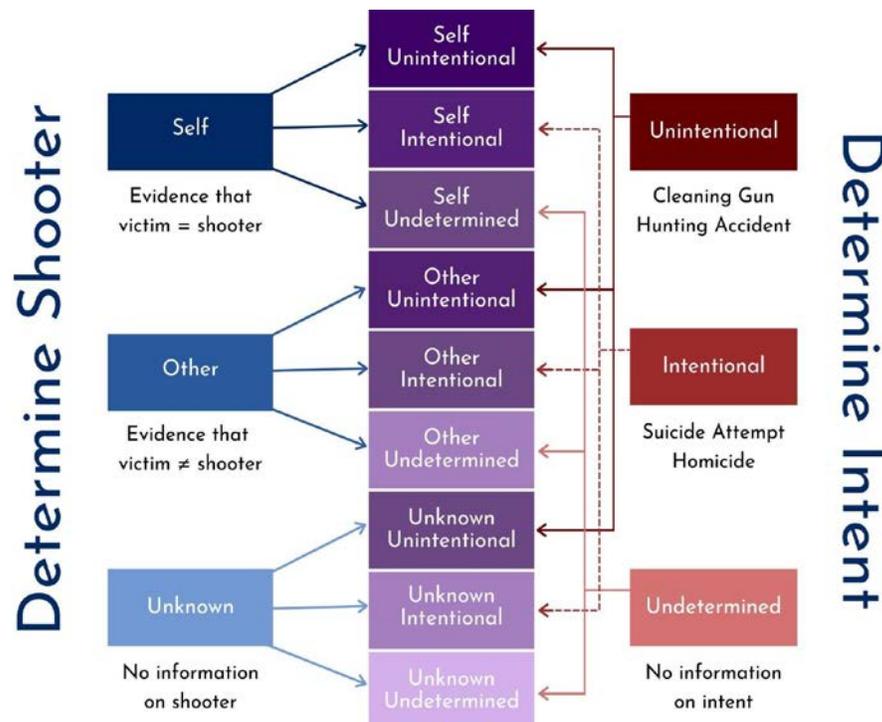
This annual report includes some of the first data on firearm injuries during the early part of the COVID-19 pandemic, including death data through 2020 and ED data through 2021. The rate of firearm deaths and ED visits for firearm injury both increased in 2020, while the ED visit rate decreased slightly in 2021 but is still higher than pre-COVID-19.

Note that NC DETECT does not yet have a syndrome definition for firearm injury due to legal intervention.

Understanding Intent

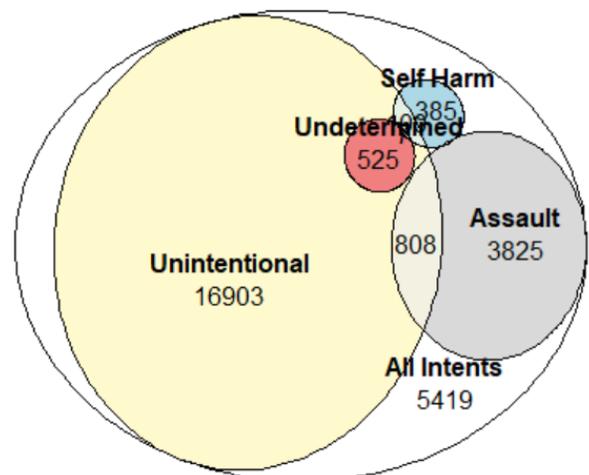
Firearm injuries and death are typically broken down by intent categories, including self-harm/suicide, unintentional, assault/homicide, and undetermined. NC-VDRS data have detailed intent information, consolidated from multiple sources. ED visit data have slightly different case definitions than either death certificate or more curated NC-VDRS data. ED visits coding may err on the side of coding firearm injury as unintentional, given a lack of definitive information and/or self-harm / mental health stigma from self-identifying self-harm; this means firearm injury due to self-harm is likely underreported in firearm injury related ED visits.

For communication purposes, **harmonizing** intent categories across datasets will be very useful. We created an updated diagram (below) to describe shooter / intent relationships.



Above: Harmonized firearm data intent model and type crosswalk

Though ED data are the timeliest data we have available, they have unique challenges as well. We continue to review firearm case definition conflicts. **Our updated 2016-2021 ED data analysis** revealed over 800 visits that were coded as both assault/intentional and unintentional, and overlaps between self-harm, unintentional, and undetermined case definitions also exist.



Right: Euler diagram of NC firearm-related

ED visits by initial intent coding, 2016-2021 ED data

Note: 5419 ED visits were identified as firearm injury but intent could not be determined with the information available.

Coming Soon

Syndrome & Intent Validation Studies

Our syndrome validation work during the previous contract year revealed conflicting intent categorizations when the CDC syndrome definition for firearm-related injuries was applied to our NC DETECT data. In response, the NC-FASTER team developed a novel intent and shooter coding schema, which separated the overall intent of each firearm injury from the shooter (see page 10, above). When the team applied this novel schema to the original study sample via chart review, it was often found that open-text fields (i.e. chief complaint and triage note) did not match the reported discharge diagnosis code in terms of intent. For example, the triage note would describe an assault injury, but the diagnosis code entered was “W34. Accidental discharge from unspecified firearm.” In several records, the chief complaint used the exact same verbiage as the W34 ICD-10-CM code, making it difficult to distinguish if the injury was truly accidental or simply a reflection of an electronic medical record protocol. Given the limitations that were discovered, this year the team is focussing on identifying specific facilities and/or counties that frequently used W34 codes in the chief complaint and discharge diagnosis fields.

Additionally, in 2021, NC DETECT transitioned to a new data aggregator, Care Evolution. While this did not alter the data elements reported from individual facilities, it did change the process by which the facilities provide data to the aggregator and how the data are made available for our NC DETECT database. Because our team has already evaluated the efficacy of firearm-related injury identification in pre-transition data, we pulled an additional 8 weeks of data from Q3 and Q4 of 2021 (4 weeks per quarter) after the transition to Care Evolution was complete. This year, the is looking at both the application of the CDC syndrome definition and the use of W34 codes in these new data, and comparing trends to the older data, in order to identify any major discrepancies since the transition. Ideally, no discrepancies should be found, as the transition should not have impacted the quality of the data itself.

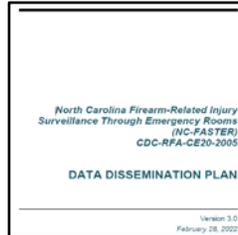
That report will be available on the CCHI website in Fall 2022.

New Data Dissemination Plan, Reports

A new data dissemination plan was released in Summer 2022 (see excerpt, right).

The NC-FASTER data dissemination plan will be posted to the CCHI NC DETECT website in Fall 2022.

Quarterly data fact sheets are available on the [CHHI NC DETECT website](#).



Product	Details	Audience	Frequency of Data Update
Injury and Violence Prevention Branch (IVPB) Firearm-Related Injury Webpage	Annual fact sheets (see below), quarterly reports (see below), recorded presentations, slide sets https://www.injuryfreenc.ncdhhs.gov/DataSurveillance/index.htm https://www.injuryfreenc.ncdhhs.gov/safestorage/index.htm	Partners, General Population	As Needed
IVPB Firearm-Related Injury ED Visits Reports	Link to Statewide and county- or regional-level (as allowed within suppression policy) 2-page report on firearm-related injury ED visits on NC DETECT website	Partners	Quarterly
IVPB Firearm-Related Injury Fact Sheets	Summary statistics on firearm-related deaths and ED visits	Partners, General Population	Annually
NC Firearm-Related Injury Metrics included on NC DETECT Public Dashboard	Publicly available dashboard with a variety of metrics; includes NC DETECT ED visit data for firearm-related injury	Partners, General Population	Quarterly
NC DETECT Website	Statewide and county- or regional-level (as allowed within suppression policy) 2-page report on firearm-related injury ED visits	Partners, General Population	Quarterly
	IVPB firearm-related fact sheets and reports will also be available on the NC DETECT website, in addition to embedding the NC-FASTER public dashboard		As Needed
Peer-Reviewed Journal Articles Presentations	TBD	Various	N/A
	Annual FASTER Reverse Site Visit with CDC Conferences TBD	Various	N/A

LEADS Linkage of NC-VDRS to ED Visit Data

In Spring and Summer 2022, our team has focused on linking ED visit data to NC Violent Death Reporting System (NC-VDRS) data to better understand prevention opportunities for firearm-related deaths. As of June 2022, we have harmonized the key variables from both data systems in preparation for linkage and begun the linkage process. Data linkage will allow us to identify some prior ED visits that may have been opportunities for intervention. This effort will also allow us to address cross-cutting questions not otherwise possible without linking data sources together.

The project is being run in conjunction with an **APHA data science linkage** project that aims to identify ED visits before suicide, through linking NC-VDRS and ED visit data. As around 2/3 of suicides involve a firearm and 2/3 of firearm deaths are self-inflicted, it makes sense to approach these overlapping linkage projects for NC-VDRS and NC DETECT ED visit data together.

A report addressing this linkage effort will be released in Fall 2022.

Data Quality Report

An update **NC-FASTER Data Quality Report** will be to be released in Fall 2022.