Cost of Non-fatal Firearm Injuries in Pennsylvania, 2016-2021

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Main Findings

Information on the prevalence and cost of firearm injury is difficult to find and typically lacks important details. Using a rich dataset from the Pennsylvania Health Care Cost Containment Council (PHC4), researchers from PCCD/IUP performed a statistical analysis of non-fatal firearm injuries from 2016 to 2021, finding the following:

- **Initial injury totals and costs:** Over the five-year timeframe, an estimated 10,640 new, non-fatal firearm injuries occurred in Pennsylvania for which patients received treatment. The medical cost of initial treatment for these injuries was $308.4 million, or over $51 million per year. The average cost of treatment was $34,837 in 2020.
- **Rising medical costs and injuries:** The number of total injuries increased by 20 percent and the medical cost for these injuries increased by 107 percent from 2016 to 2020. The number of accidental injuries increased by 46 percent (to over 1,000 per year in 2020), with a cost increase of 195%. Assault injuries increased by 5%, with the medical costs of these injuries increasing by 81%.
- **Rises with COVID:** The number of firearm injuries rose dramatically immediately after the onset of the COVID-19

pandemic and resulting shutdowns. Both accidental and assault injuries rose to their highest levels over the timeframe studied.

- **Economic and Racial Disparities:** The poorest one-fifth of zip codes incurred nearly 60 percent of the total medical costs of firearm injuries. Two-thirds of all patients of firearm injuries were Black, although Black people make up only 11 percent of the Pennsylvania population.
- **Long-term costs:** 16 percent of new injuries require additional hospital visits and incur nearly four times the medical costs, averaging over $70,000 per patient. Over 3 percent of new firearm injuries result in paralysis, increasing costs over the first year to over $100,000.
- **Full Economic Losses:** If values are placed on lost work and lower quality of life, the total economic losses of firearm injury increase by six-fold to an estimated $300 million per year and $1.5 billion.

Estimates here should be considered conservative, as they do not consider full costs to society (i.e. disability and unemployment payments) and are limited to costs only incurred during the time of visits for treatment (i.e. not counting long-term rehabilitation). Additionally, they do not include fatal injuries or shootings – for instance, over 600 people are victims of homicide by firearm and at least double that number die by firearm suicide per year. The non-fatal injury findings here are in line with estimates for U.S. injuries made separately by the Government Accountability Office and the Center for Disease Control.

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Project Disclaimer

This project was funded through a grant from the Bureau of Justice Statistics, within the U.S. Department of Justice's Office of Justice Programs. Neither the U.S. Department of Justice, nor any of its components operate, control, are responsible for, or necessarily endorse this project (including, without limitation, its content, technical infrastructure and policies, and any services or tools provided). In addition, please refer to the Information Disclaimer within Pennsylvania's Privacy Policy (http://www.pa.gov/Pages/Privacy-Policy.aspx), which is incorporated herein by reference.

In creating this report, the researchers relied upon the Pennsylvania Health Care Cost Containment Council (PHC4) for the accuracy and completeness of the data. PHC4 is an independent state agency responsible for addressing the problem of escalating health costs, ensuring the quality of health care, and increasing access to health care for all citizens. While PHC4 has provided data for this study, PHC4 specifically disclaims responsibility for any analyses, interpretations, or conclusions.

Background

A growing amount of evidence suggests that significant personal and public resources are spent on medical care for firearm injuries. Studies by both the Government Accountability Office (GAO) and the Center for Disease Control (CDC) estimate that medical costs of firearm injuries were over $1 billion annually for the United States. If additional costs to injury are added, such as values for lost earnings from work and lost quality of life, the CDC estimates total losses of $2 billion annually. Long-term costs of care, such as additional use of services for those severely injured (such as unemployment or disability compensation), could further increase that amount.

While statistics are available for the prevalence and costs of firearm injuries, they are typically aggregated to the nation or state level and lack important detail, such as changes in incidence and cost over time, reason for injury, and estimates of other economic losses due to injury, such as work and quality of life loss.

This report seeks to bridge this knowledge gap for Pennsylvania by utilizing a rich, detailed dataset of firearm injuries, procedures, and costs from the Pennsylvania Health Care Cost Containment Council (PHC4). This data includes information about patients (age, race, health insurance), health care facilities (inpatient/outpatient), injuries (reason, diagnoses), care administered (procedures, surgeries, equipment, length of stay), and costs.

Injuries and Treatment

Firearm injuries include those caused by a handgun, rifle, shotgun or similar weapon that fires projectiles. They may be unintentional, such as accidents due to cleaning or misuse, or intentional, such as in the act of violence, self-harm, or self-defense. The type of weapon and reason for the injury may affect the severity of the injury. For instance, accidental discharges during cleaning tend to result in less severe graze wounds than assault injuries.

Treatment for firearm injuries may go through several phases. First, the person injured may seek immediate treatment at an emergency

department or some other outpatient facility. If the wound is not severe, the patient may be discharged; for more complicated injuries, the person may receive more extensive care and be admitted to a hospital. Second, severe injuries that require more complex procedures will require inpatient stays, possibly for multiple days. The level and extent of care will depend on the area of the body affected by the injury, the number of procedures required, and the amount of recovery time needed from surgery. Third, some patients will require additional health services ranging from rehabilitation treatment to restore movement or functioning to additional surgeries for injury complications.

The services above, along with the equipment, materials, facilities, and personnel required to administer them, will be charged to the patient or their insurer. The payer that is billed falls into three general categories. First, the insurer may be a government-funded program, such as Medicaid, Medicare, or another public payer, such as the Department of Veteran Affairs. Second, the patient may have private insurance through their employer or be on an individual policy, possibly purchased through health insurance exchanges. Third, individuals may not have health insurance and must pay for services out of pocket.

Data & Methods

This report uses PHC4 data for the full years of 2016-2020 and the first half of 2021. The PHC4 dataset contains important variables that allow for a detailed analysis of costs over time and across patient and injury characteristics. Personal, identifying information was withheld from the research team for this study. However, PHC4 includes a number of important characteristics:

- *Patient characteristics*: Patient age, gender, race, insurer, home county and zip code.
- *Facility characteristics*: Inpatient/outpatient facility, type (i.e., general acute care), facility location.
- *Injury characteristics*: Diagnosis codes, reason for injury (accident, assault, or other/unspecified), initial or follow-up visit for injury, length of hospital stay, procedures (including surgeries performed), and location of injury.
- *Charge for service characteristics*: Dollar amounts charged for room and board, ancillary services, equipment, administered medications, specialty charges, miscellaneous charges, and staff and professional services.

Injury characteristics are identified in the PHC4 data by the International Classification of Diseases, Tenth Revision (ICD-10). The ICD-10 is used in a variety of clinical and health care applications for reporting, morbidity statistics, and billing. It includes codes for firearm injuries, classifying them into reason categories: assault, self-harm, unintentional, undetermined, and several other categories (WHO, 2012).

Report Scope

This report focuses only on non-fatal firearm injuries. The PHC4 has data for any person that sought treatment for a firearm injury over the timeframe. While it contains information on people who received treatment and died after, it does not have information on firearm fatalities for individuals who died before they could receive care.

Combining data on non-fatal injuries and firearm fatalities will be the focus of a later study.

Because approximately 90 percent of suicide attempts with firearms result in death (compared to 3-10 percent of non-firearm suicide attempts), non-fatal firearm injuries due to intentional self-harm are also removed from the data. Results are presented comparing the two reasons for firearm injury – assault and accident, which make up over 95 percent of all injuries in the dataset. A third category combines undetermined and other rare categories (justified shooting, terrorism, etc.).

The ICD-10 also classifies firearm injuries by gun size (handgun, rifle/shotgun/other large gun, and unspecified). However, nearly 90 percent of all injuries are classified as "unspecified," making this category largely unusable in the analysis.

Analytical Methods

The analysis proceeds in three main steps to allow comparison to other firearm studies and to take full advantage of details in the data. First, the analysis focuses on new (initial) firearm injuries. This allows for the most accurate estimates of injury prevalence in the population and the immediate costs associated with new injuries. The number of new injuries is tracked over time, and characteristics of these are described.

Second, a substantial group of those receiving firearm injuries must return for follow-up care, sometimes for years. The report compares patients who receive care only initially vs. those who return multiple times. Furthermore, patients that received an additional diagnosis related to paralysis are compared to others and their follow-up visits and costs are analyzed for comparison. This grouping of patients allows for the calculation of a severity rate for those injuries requiring follow-up care and a paralysis rate for the number of injuries that result in paralysis.

Finally, since medical costs make up only a fraction of the full economic losses that a person experience due to injury, the report follows methods used in previous health economic studies to estimate the full extent of losses (please see the technical appendix for a description of these methods). Bureau of Labor Statistics data on lost work for specific injuries

was used to estimate lost days of work based on injury severity (length of stay, medical costs, etc.). Using zip code area income data, cost of lost earnings from work based on likely days missed are calculated. Values for decreased quality of life due to injury are calculated based on injury severity details. The total economic loss of injury is then calculated and presented both on average (per injury) and in yearly aggregates.

Initial Firearm Injuries and Medical Costs Over Time

Over the six-year period from 2016 to 2021, an estimated 10,640 non-fatal firearm injuries occurred in Pennsylvania for which patients received treatment. The medical cost of initial treatment for these injuries was $308.4 million, or over $51 million per year. Costs of ongoing treatment and other economic losses due to treatment are discussed in a later section.

During this timeframe, 5,441 of these injuries were due to assault, according to ICD-10 diagnosis coding, costing $195 million; 4,810 were due to accident, totaling $102 million; and 422 were due to other/unspecified reasons, totaling $11 million.

Looking across totals for each year, firearm injuries were fairly consistent in a number of characteristics. Across yearly totals for the state:

- 85-95% of injuries occurred in urban counties;

- 70-82% of injuries were treated in inpatient facilities;

- 67-80% of visits due to injury were overnight stays in the hospital; and,

- 67-80% listed government insurance as the primary payer to be billed by the healthcare facility.

Firearm injuries and costs for initial treatment have risen substantially since 2016. The number of total injuries increased by 20 percent from 2016 to 2020, the last year of full data (estimated increases to 2021 are even higher). The medical cost of these injuries increased by 107% over that time. The number of accidental injuries increased by 46 percent with a cost increase of 195% from 2016 to 2020. Assault injuries increased by 5%, with the medical costs of these increasing by 81%.
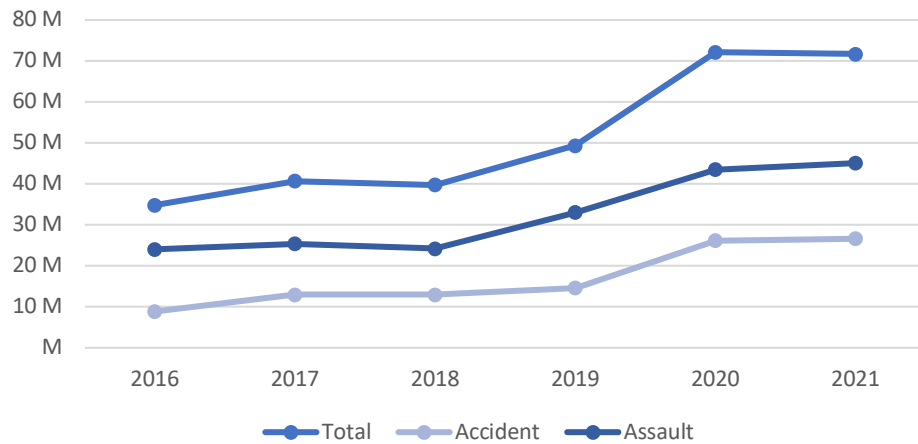
Figure 1 shows these trends over time. The total counts consist of the 9,384 initial firearm injuries that occurred between 2016 and the first half

of 2021. Estimations for the 2nd half of 2021 increase the overall six-year total to 10,640 new injuries.

FIGURE 1: Yearly Trends of Firearm Injuries and Medical Costs
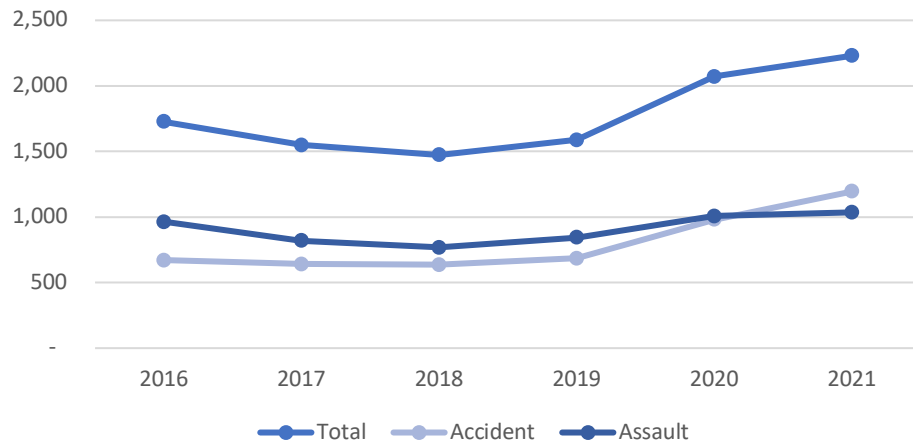
1a. Total Injuries

1b. Total Medical Costs

Source: Authors calculations of PHC4 data, 2016-2021.
Note: A third category beyond Accident and Assault consists of other reasons or undetermined firearm injuries. As this makes up less than 5% of the total, it is not included in this and the following graphs.

From 2016 to 2018, total injuries fell by about 250 incidents, driven by the large decrease in assault injuries. After 2016, injuries due to accident

begin a dramatic rise, nearly equally those due to assault in 2020 and surpassing them in 2021. The rise in medical costs also begins a rapid increase after 2018. However, costs of accidental injuries do not rise above those due to assault, since they tend to be less severe and require fewer procedures initially, which is discussed below.

TABLE 1: State Medical Cost of Assault Injuries, 2010 Estimates

State	2010 Cost of Assault Injury (millions in 2020 $)	2010 Population	$/Pop
Arizona	14.6	5.1	2.9
California	117.1	33.8	3.5
Maryland	16.3	5.3	3.1
North Carolina	16.9	8.1	2.1
New Jersey	13.3	8.4	1.6
Wisconsin	5.1	5.4	0.9
Pennsylvania	**16.5**	**12.3**	**1.3**

Source: PA estimate from PHC4 data. State comparisons come from Howell et al. (Table 5, 2010).
Note: The PA number was estimated assuming a similar cost growth from 2010-2015 as that found for the timeframe under analysis of 2016-2021.

Few studies offer state estimates of firearm injury costs for which to compare the totals found above. Table 1 provides some context for these totals, however. Although the state figures come from 2010 (before the timeframe under study for this report), estimates of Pennsylvania costs in 2010 were made using the PHC4 data. The resulting comparison suggests that the Commonwealth falls in line with estimates for other states. However, given the large increase in medical costs overall and the number of injuries, a more recent state comparison would be useful.

At least three factors are contributing to rising firearm injury costs, partially explaining why costs are growing faster than total injuries, as shown in Figure 1 above. First, costs rise with the number of injuries. Second, cost inflation in medical care was about 15 percent from 2016 to 2021 (BLS, 2022). Third, the average length of stay for initial injuries increased by more than a full day, rising from 5.5 days in 2016 to 6.9 days in 2021.[1]

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[1] The analysis in this report is unable to determine whether longer length of stay results in better health outcomes for patients.

Age-adjusted injury prevalence rates are presented in Figure 2. As seen for total injuries, there is a steep increase in the number of injuries per 100,000 persons, from 12.4 in 2018 to 18.8 in 2021. Rates increased both in terms of accidents and assault and across both rural and urban counties. While the child rate (under 15 years of age) is relatively low, it doubled from 1.3 per 100,000 children in 2016 to 2.7 in 2021.
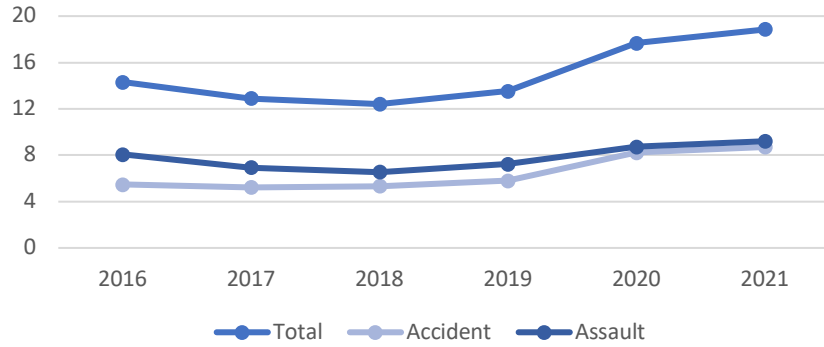
In a study of state firearm hospitalization rates from 2000-2016, Smart et al. (2021) found comparable numbers for Pennsylvania. The authors found that Pennsylvania had a hospitalization rate of about 15 per 100,000 in 2005, falling to about 10 per 100,000 in 2016, which is the rate found in the current study (total rate of 14.3 per 100,000; inpatient rate of 10.0).

Pennsylvania falls near the top of surrounding states in terms of rates (13th in the nation overall), according to Smart et al. (2021). Average yearly rates of hospitalizations per 100,000 persons follows:
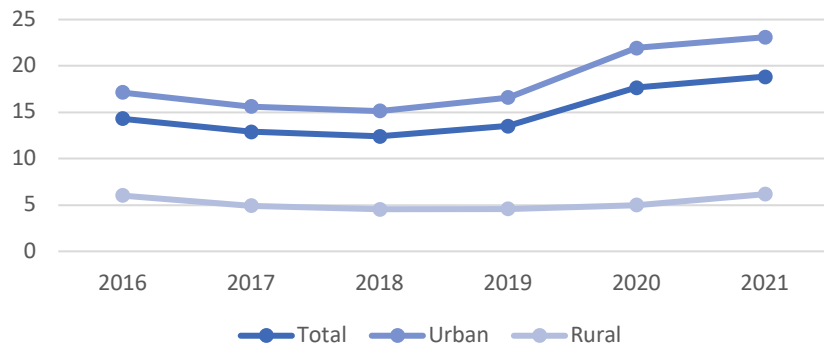
- Maryland: 16.4
- New York: 8.4
- New Jersey: 7.9
- Ohio: 10.2
- Pennsylvania: 12.4
- West Virginia: 9.9.

Using the current data, estimates suggest that the rate of inpatient stays has fallen to an average of 10.0 per 100,000 in Pennsylvania, but rose to 12.6 in 2020. State comparisons on more recent data would be useful, as would comparisons across all injuries (inpatient and outpatient) and by reason.

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FIGURE 2: Injury Prevalence Rates, per 100,000

2a: Rate by Reason for Injury

Legend: Total, Accident, Assault (Years 2016–2021; Y-axis 0–20)

2b: Rate by Urban/Rural County

Legend: Total, Urban, Rural (Years 2016–2021; Y-axis 0–25)
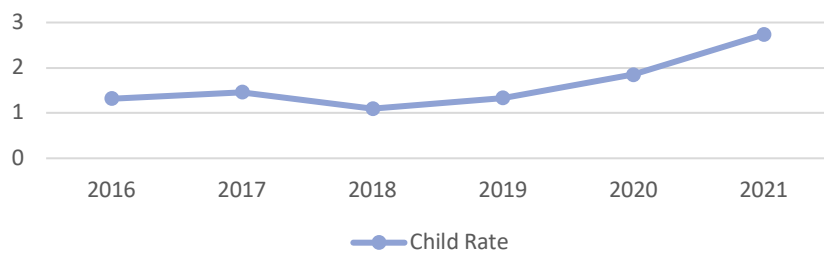
2c: Child (0-14 years) Rates, per 100,000 Children

Legend: Child Rate (Years 2016–2021; Y-axis 0–3)

Source: Authors calculations of PHC4 data, 2016-2021.

Quarterly data in Figure 3 gives a bit more detail as to the timing of recent increases. Both assault and accidental injuries increased to their highest quarterly total over the timeframe in the third quarter of 2020. Every quarter since Q2 2020 has seen an accident injury count higher than any in the previous years.

While quarterly injuries dropped in Q1 2021, they did not drop to the level of the first quarter in previous years. Figure 3b shows the level of variation across quarters. On average, there are 110 more injuries in Q3 (July-September) than Q1 (January-March), perhaps due to people doing outdoor activities (including those involving firearms), longer daylight hours, and more interactions with the potential for conflict.

FIGURE 3: Quarterly Trends
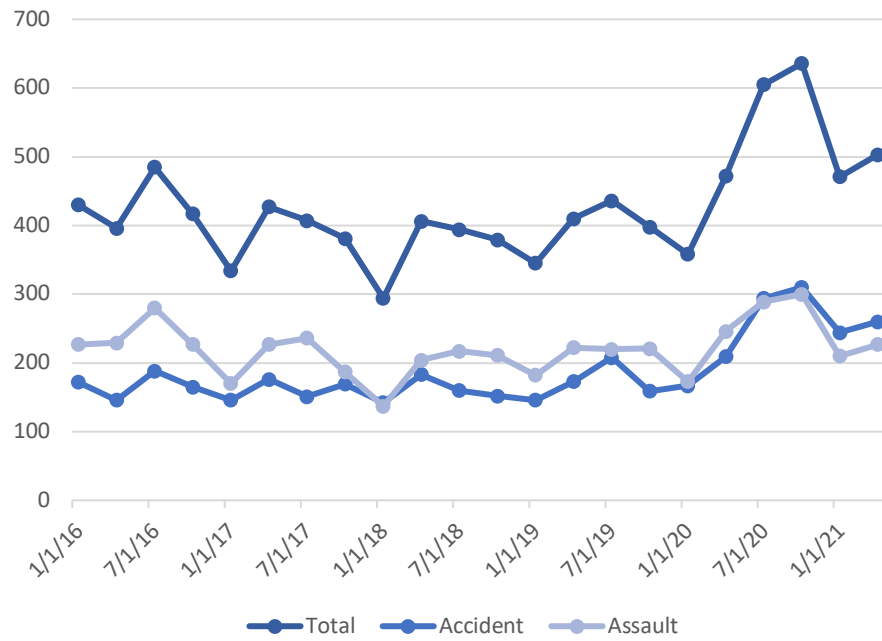
3a: Total Injuries
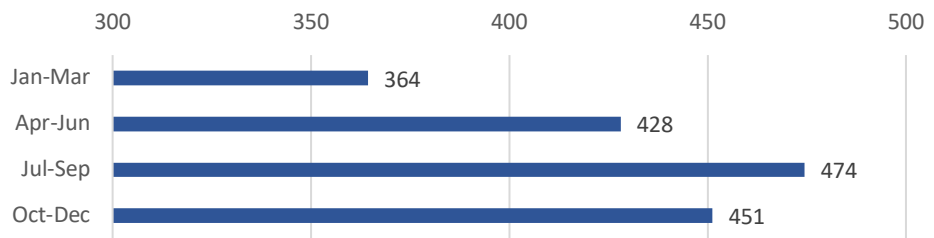
3b: Average Quarterly Variation in Injuries

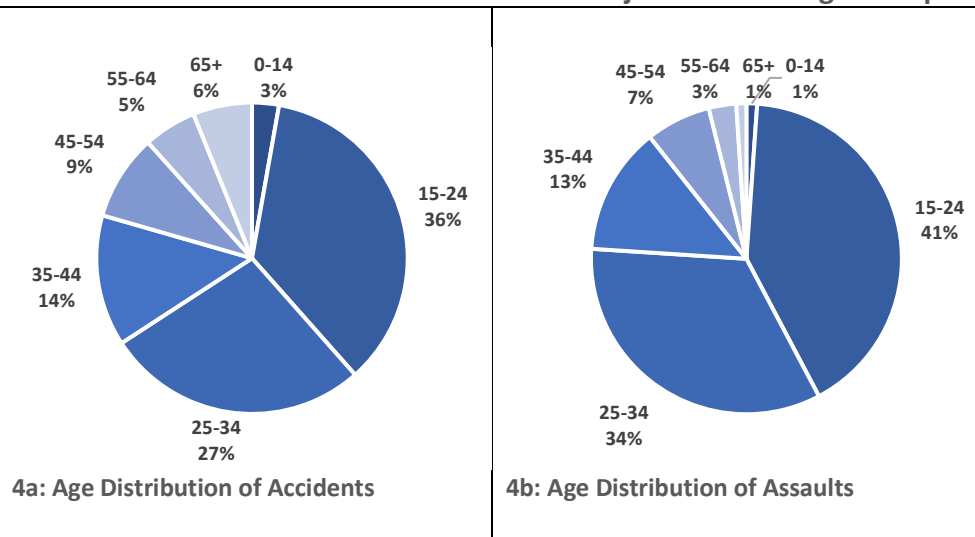*Source:* Authors calculations of PHC4 data, 2016-2021.

Patient and Injury Characteristics

This section describes the patients who required health care for firearm injuries, considering age, race, and location. Overall, the findings show considerable disparities across age, race, area population, and income. In the analysis that follows, injuries a limited to those that occurred between 2016 and 2020, as estimations for various subgroups for the partial year of data in 2021 would lack accuracy.

Age Group Comparisons

Injuries to people between the ages of 15-34 make up a majority of all firearm injuries between 2016-2020. Figure 4 shows that this is true for both accidents (63 percent of all accidents) and assaults (75 percent).

FIGURE 4: Distribution of Medical Costs and Injuries Across Age Group

4a: Age Distribution of Accidents

4b: Age Distribution of Assaults

Source: Authors calculations of PHC4 data, 2016-2021.
Notes: The distribution of totals is based on all initial injuries over the time frame studied.

FIGURE 5: Injury Totals, Rates & Average Costs, by Age Group
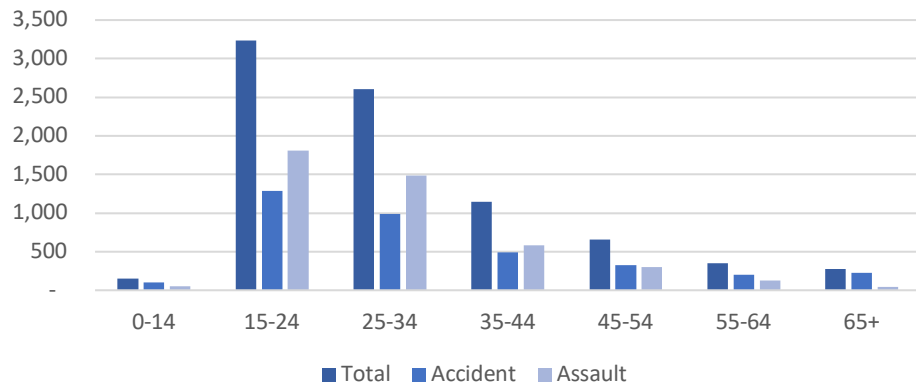
5a: Total Injuries, 2010-2021
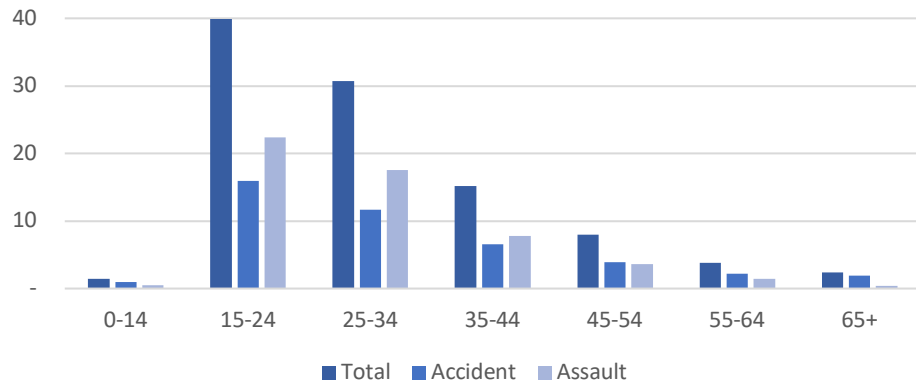
5b: Age-Specific Injury Rate (per 100,000 persons, yearly average)

5c: Average Costs of Care for Initial Injuries

Source: Authors calculations of PHC4 data, 2016-2021.
Notes: Rates are calculated using Census population estimates for each age group.

Figure 5 shows the differences in counts, rates and average costs by age group. For those between 15 and 24 years, 3,233 injuries occurred over the five-year span, costing $87.8 million. This age group has an injury rate of 40 per 100,000 (yearly average), three times the rate for the overall populat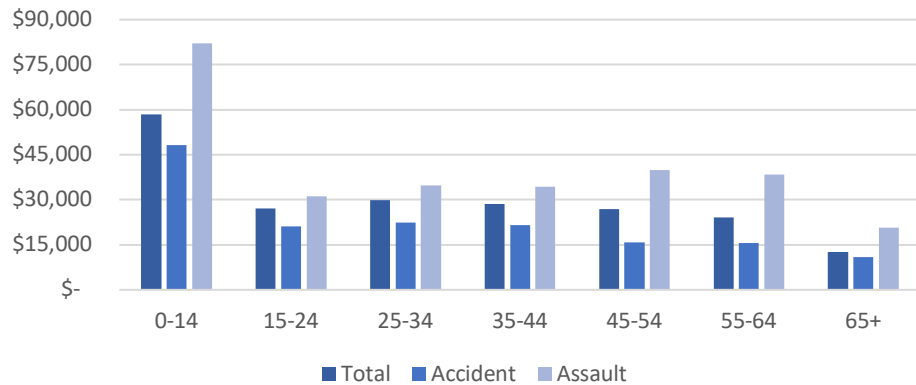ion. People between 15 and 44 (three age groups shown) have higher injury rates due to assault than due to accidents, while the opposite is true for other age groups.

Although injuries to children between 0 and 14 years is relatively rare, initial care is much more costly – double the average cost of other groups.

Comparisons Across Zip Codes

As patient home zip codes are included in the PHC4 data, analysis based on the location of where the patient lives is possible. Using zip code data from the U.S. Census, zip codes were sorted by average household income and segmented into five equal groups. Injury rates were calculated for each group based on the 2020 zip code population.

FIGURE 6: Injury Rates Across Zip Code Income Level

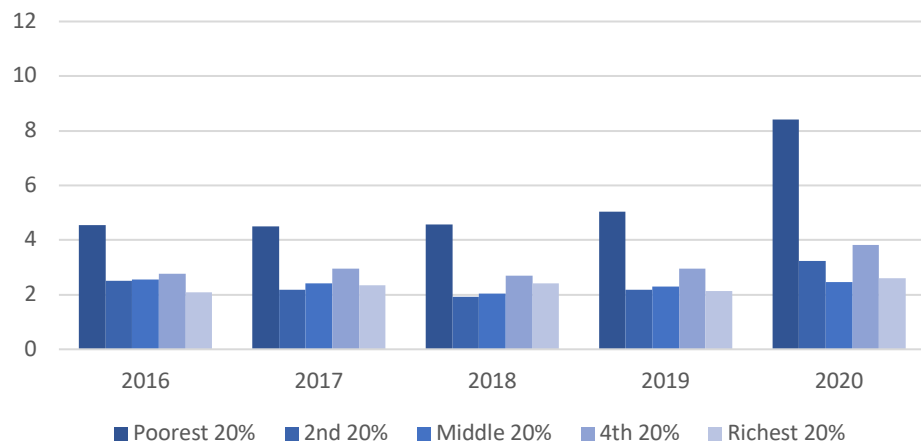**Poorest 20%** **2nd 20%** **Middle 20%** **4th 20%** **Richest 20%**

6a: Assault Rate per 100,000 persons

Poorest 20% **2nd 20%** **Middle 20%** **4th 20%** **Richest 20%**
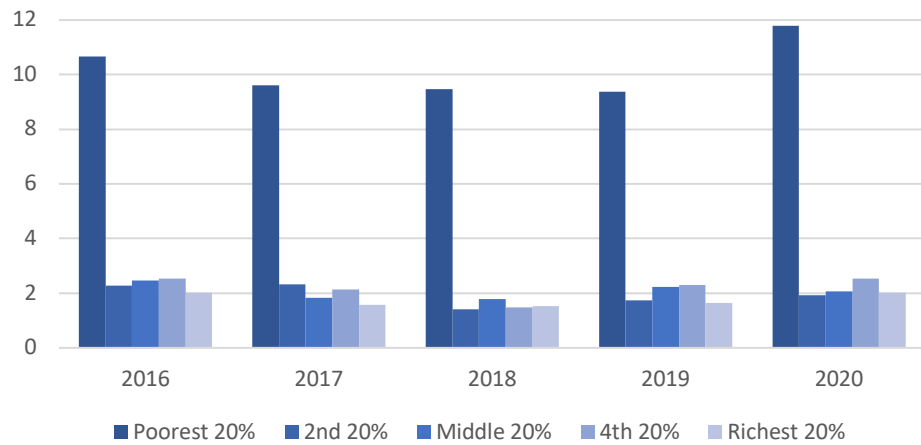
6b: Accident Rate per 100,000 persons

Source: Authors calculations of PHC4 data, 2016-2020. Zip code income and population data comes from the U.S. Census 2020 American Community Survey.
Notes: Rates are approximated using zip code population estimates. Zip code quintiles are based on mean income.

Figure 6 shows that not only does the poorest zip code group have the highest assault and accident injury rates, they also experienced the largest growth over the five-year period (11 percent increase in assault rate and 85 percent increase in the accident rate). The other four groups either remained the same or decreased in assault rates. On the other

hand, the 2nd, 4th, and highest income groups all increased in accident rates by 25 percent or more.

FIGURE 7: Injury Rates Across Zip Code Population

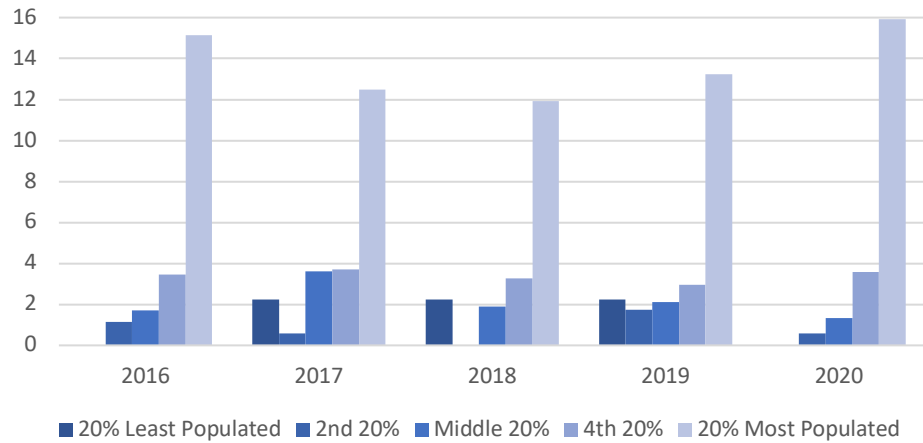**7a: Assault Rate per 100,000 persons**

7b: Accident Rate per 100,000 persons

Source: Authors calculations of PHC4 data, 2016-2020. Zip code income and population data comes from the U.S. Census 2020 American Community Survey.
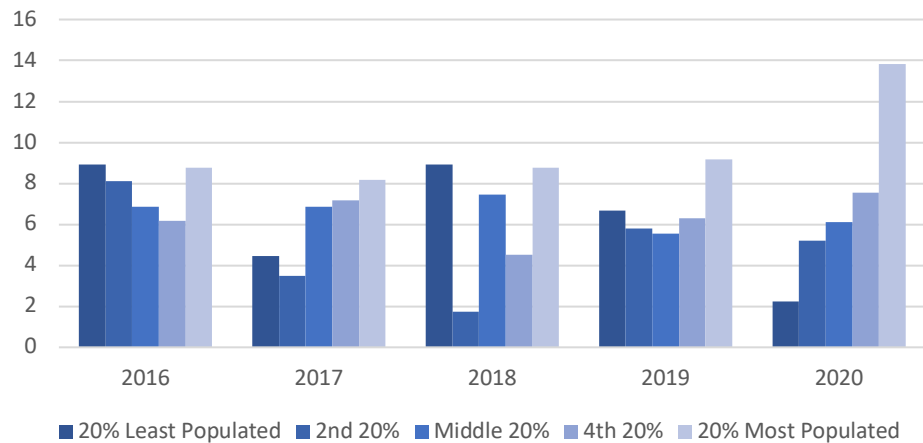*Notes:* Rates are approximated using zip code population estimates. Zip code quintiles are based on population.

Altogether, 40 percent of accidents and 61 percent of assaults occurred in the lowest income group of zip codes, which made up only 23 percent of the population.

Figure 7 shows based on zip codes ordered and grouped by population. The most populated zip codes have substantially higher assault injury rates than other areas. While accidental injury rates were similar in 2016, the group of most populated zip codes have experienced the highest growth, with the rate for that group increasing by 58 percent. The group of most populated zip codes make up 72 percent of the state population but 86 percent of the firearm injuries.

Distribution of Injuries by Race

A final description of those who were injured is presented in Figure 8. Black patients make up a disproportionate number of firearm injuries, with 70 percent of assault and 54 percent of accident injuries. In 2020, approximately 75 percent of the Pennsylvanian population was White while 11 percent were Black.

This large racial disparity coincides with previous research. A recent Pennsylvania study of homicides from 2012-2020 found that 62 percent of homicides over that time were black (Yerger et al., 2022).

FIGURE 8: Distrbution of Firearm Injuries by Race

8a: Injuries due to Assault

8b: Injuries due to Accident
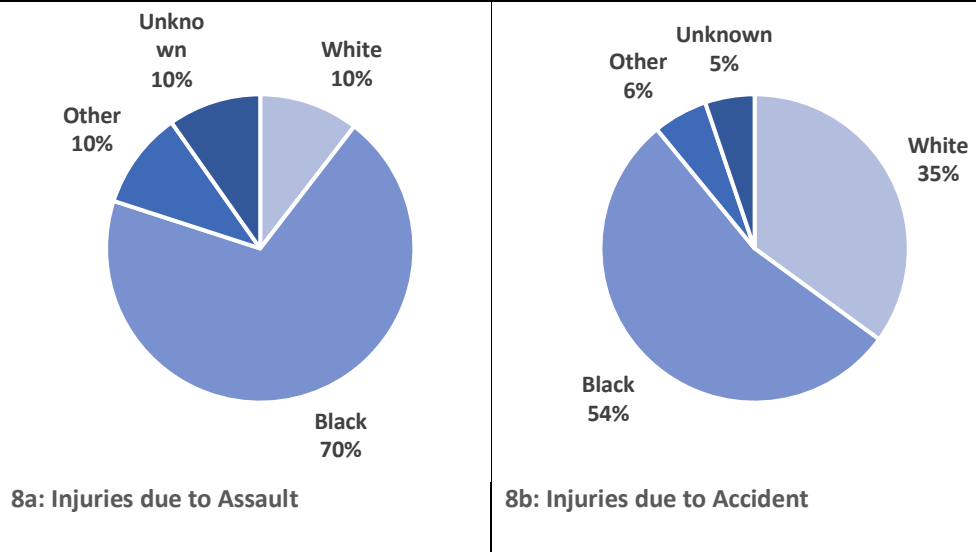
Source: Authors calculations of PHC4 data, 2016-2020.

Medical Costs of Firearm Injuries

The medical costs of firearm injuries are increasing, but not simply due to the greater number of injuries since 2016. The average cost of initial care for a firearm injury increased from $20,154 in 2016 to $34,837 in 2020 (the last year of full data), an increase of 73 percent. Average costs for accidents increased by 102 percent and assault injuries by 73 percent. Increases in average costs over time are shown in Figure 9.

FIGURE 9: Average Medical Costs for Initial Visits, by Year
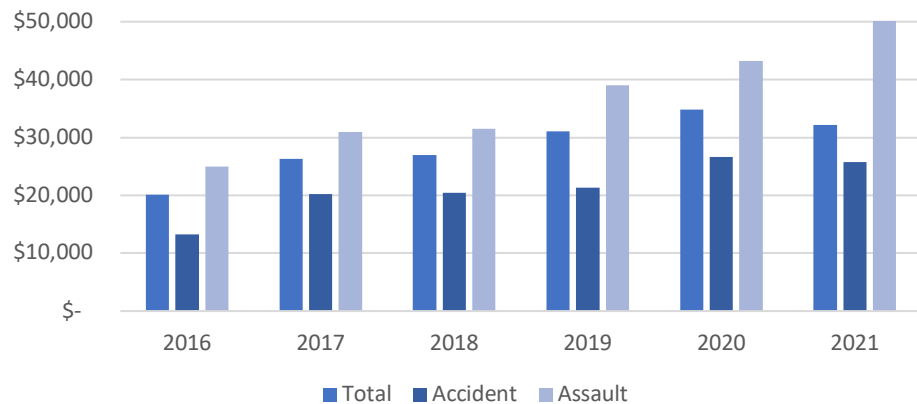
9a: By Reason for Injury
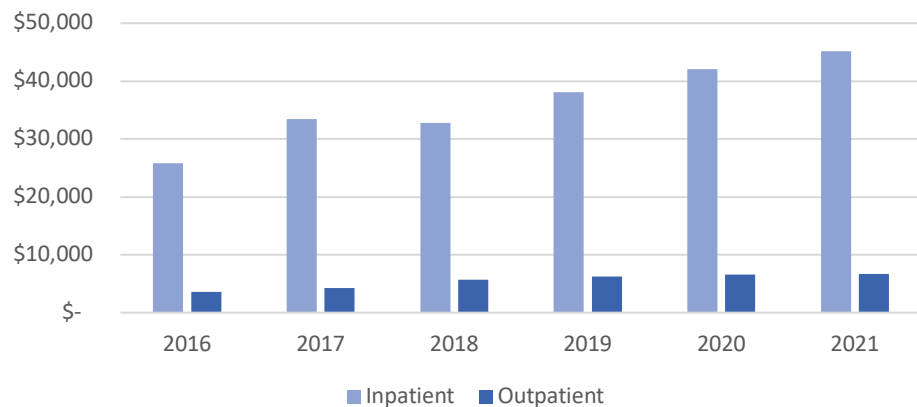
9b: By Inpatient vs. Outpatient Visits

Source: Authors calculations of PHC4 data, 2016-2021.

Over the timeframe of study, inpatient visits made up 77 percent of all care for firearm injuries. From 2016 to 2020, the average cost of inpatient visits rose from $25,790 to $42,101, an increase of 63 percent.

FIGURE 10: Distribution of Five-Year Medical Costs, by Zip Code Quintiles

10a: By Zip Code Average Income | 10b: By Zip Code Population

Note: Zip codes were grouped into mean income (left) and population (right) quintiles for comparison (20 percent of zip codes with lowest mean incomes vs. 2nd 20 percent, etc). Percentages indicate the share of total five-year medical costs of firearm injuries ($236.8 million from 2016-2020 across the five zip-code groups.

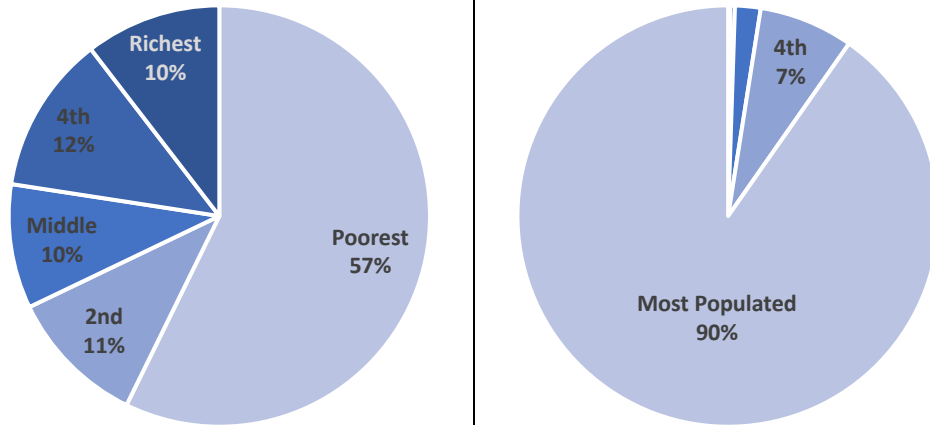As mentioned above, zip codes with the lowest average household income experienced 51 percent of all injuries. These injuries accounted for 57 percent of total medical costs from 2016-2020 ($135 million out of $236 million). The most populated zip codes account for 90 percent of total costs incurred over this time.

Cost by Insurer

Over five years, 65 percent of inpatient/outpatient visits were submitted to Medicaid and five percent to Medicare. Twenty percent of injuries were submitted (primarily) to private insurance and 7.5 percent of those injured were uninsured. For comparison, the Center for Medicare and Medicaid Services reports that the federal, state, and local government account for about 51 percent of overall U.S. health spending (CMS, 2022a).

FIGURE 11: Distribution of Injuries by Patient Plan

Pie chart showing:
- Other Govt. 1%
- Uninsured 8%
- Unknown 1%
- Private 20%
- Medicare 5%
- Medicaid 65%
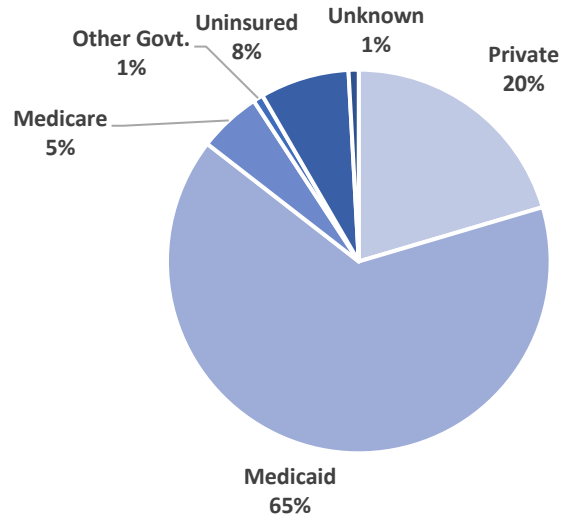
Note: Total initial injuries over the full timeframe.

However, over the five-year span, the burden of costs has grown increasingly for government plans, rising from $27 million in 2016 to $59 million in 2020, 82 percent of all injury costs in 2020. Figure 12 shows total costs by insurer, along with yearly injuries. It should be noted that amount of costs billed to those without insurance increased from $1 million in 2016 to over $5 million in 2020.

FIGURE 12: Total Yearly Costs and Injuries, by Patient Plan
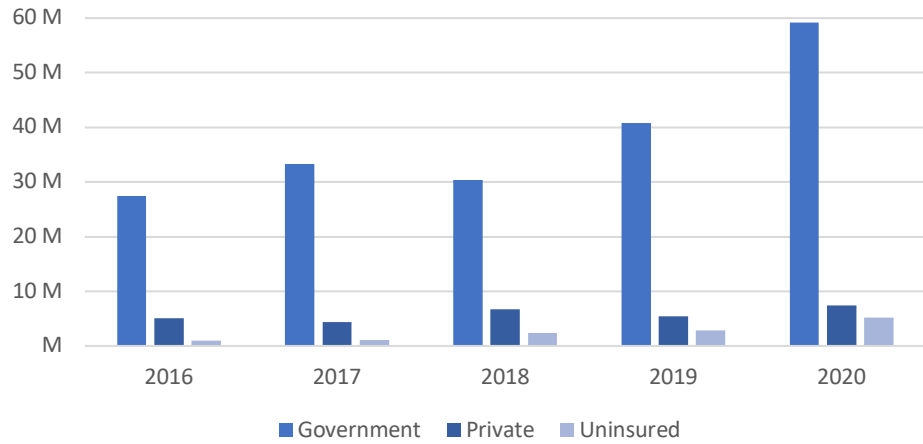
12a: Yearly Costs, in millions
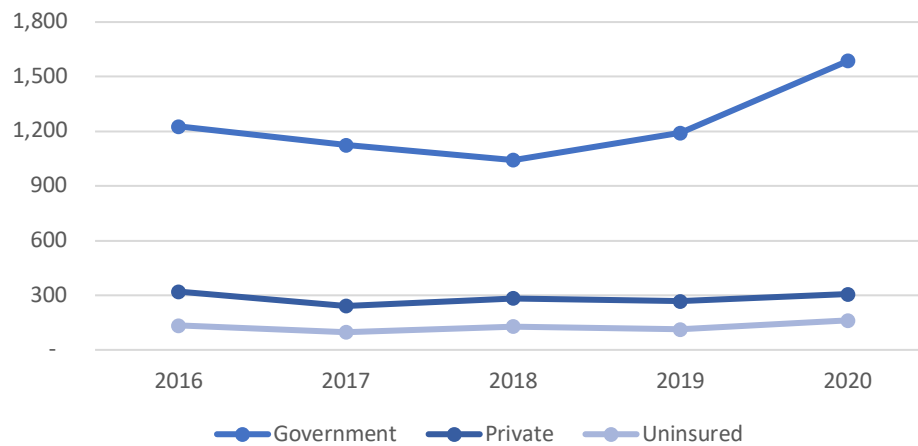
12b: Yearly Injuries

Notes: Government payers include Medicare, Medicaid, and other government insurance.

Cost by Area of Injury

The location of the firearm injury, and the resulting procedures and surgeries required to treat the injury, are related to costs. Figure 13 illustrates the difference in costs based on procedures/surgeries performed on various areas of the body.

The largest group of initial injuries did not require a surgical procedure, such as graze wounds in outpatient facilities, and had the lowest average cost for treatment ($6,366). The next largest injury groups were those requiring procedures to multiple body systems and those to the torso (broadly defined to include lymphatic, respiratory, gastrointestinal, and other systems). Average costs of treatment (including surgeries) to these systems are much higher – $54,035 for multiple systems and $37,592 for injuries in the torso, on average.

The severity of injuries may be growing, requiring more procedures. In 2016, 38 percent of initial injuries did not require any procedure. This number fell to 34 percent in 2020, steadily falling in the years in between. Additionally, the number of injuries requiring surgeries for multiple body systems increased from 28 percent of injuries in 2016 to 33 percent in 2020.[2]

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[2] Alternatively, the increase in procedures and surgeries could be related to the proximity to Level 1 trauma centers. If the number of injuries increases for people living in areas close to trauma centers, typically urban areas, relative to others, then the average number of injuries receiving procedures could also rise.

FIGURE 13: Average Cost and Injury Distribution, by Body System
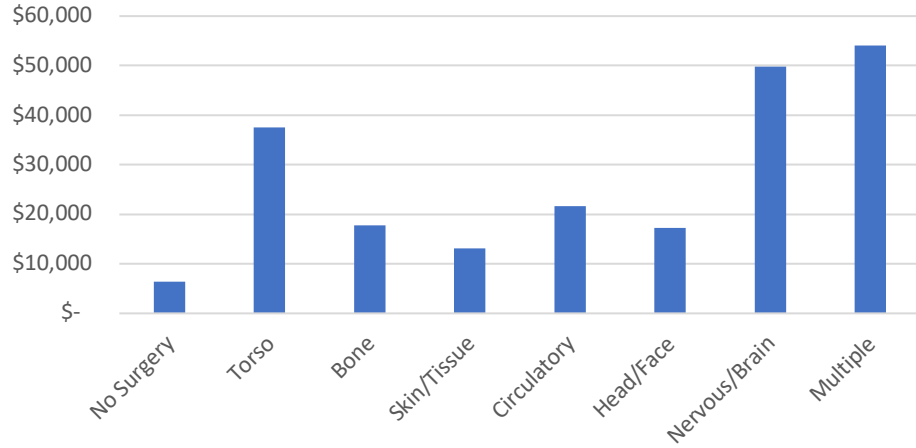
13a: Average Costs of Initial Visits, No Surgery vs. Body System
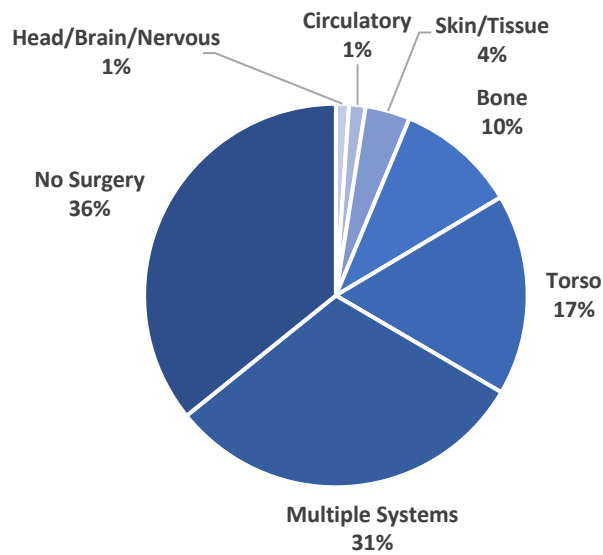
13b: Percentage of Visits with Surgery on Various Body Systems

Note: Costs and the distribution of injuries are for all initial injuries from 2016 to 2020. Body system groups were created based on the ICD PCS procedure codes associated with a given inpatient/outpatient visit.

Full Economic Costs of Initial Firearm Injuries

Medical costs related to injury or illness are only part of the overall economic and personal costs that a person incurs. Health economists have found that medical costs may be only a small percentage of overall costs if one also considers lost work and lost quality of life.

Lawrence et al. (2000) lays out a method for estimating the total economic costs to an injury by including medical costs, work losses, the value of lost ability to perform household work (home production loss), and the value of lost quality of life (i.e. the intangible cost of not being able to do as much after an injury as one was able to do before). Recent research by the CDC has estimated many of these costs for a wide variety of injuries and is used for comparison here (WISQARS, 2022).

Table 2 presents the estimated average economic costs of initial firearm injuries from 2016 to 2022, meaning that long-term care is not considered here – the estimates should be considered to be a lower bound. The average, total economic cost of injuries leading to inpatient stays was $221,575, while that of outpatient visits was $31,744.

If we total the full costs of all injuries, we find that they rose from $220 million in 2016 to $455 million in 2020. The economic costs of new firearm injuries over five years was $1.5 billion, as shown in Figure 14.

FIGURE 14: Total Economic Costs of Initial Firearm Injuries, by Year
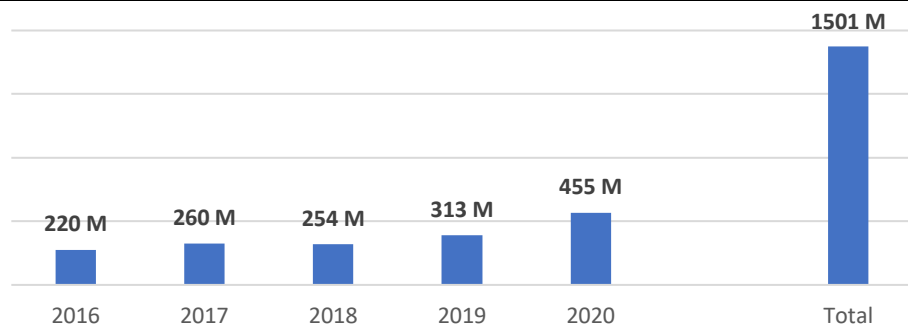
Note: Totals include medical, work loss, home productivity loss, and quality of life losses for initial firearm injuries.

TABLE 2: Economic Costs of Initial Firearm Injuries, vs. Comparison Studies

	PA Estimate		Comparison Estimates	Comparison Source
Inpatient				
Medial Costs	$	34,884	$ 30,703	GAO
Work Loss	$	5,526	$ 9,251	Unintentional, Hospitalizations: WISQARS (2022)
- Days Lost		50.1	66.0	Peterson, et al. (2020)
Home Production Loss	$	1,127		
Quality of Life Loss	$	181,142	$ 93,341	Unintentional, Hospitalizations: WISQARS (2022)
Total	$	221,575	$ 183,883	Unintentional, Hospitalizations: WISQARS (2022)
n		6,501		
Outpatient				
Medial Costs	$	5,223	$ 1,478	GAO
Work Loss	$	90	$ 1,524	Unintentional, Treat and Release: WISQARS (2022)
- Days Lost		0.6		
Home Production Loss	$	17		
Quality of Life Loss	$	26,407	$ 13,404	Unintentional, Treat and Release: WISQARS (2022)
Total	$	31,744	$ 24,882	Unintentional, Treat and Release: WISQARS (2022)
n		1,909		
Assault				
Medial Costs	$	34,100		
Work Loss	$	4,926		
- Days Lost		48.5		
Home Production Loss	$	1,013		
Quality of Life Loss	$	181,418		
Total	$	220,466		
n		4,405		
Accident/Other				
Medial Costs	$	21,609		
Work Loss	$	3,595		
- Days Lost		29.1		
Home Production Loss	$	723		
Quality of Life Loss	$	107,084		
Total	$	132,312		
n		4,005		

Source: Pennsylvania estimates are the authors' calculations of PHC4 data. Comparison sources are indicated.
Note: All estimates and comparisons are adjusted to 2020 dollars. Please see the Technical Appendix for details on the methods used for calculating work, home production, and quality of life costs.

The findings in Table 2 suggest that the total costs of injury are about six times that of the medical costs. Quality of life losses are about five times that of medical costs ($181,142 vs. $34,884), higher than those estimated by the CDC WISQARS. However, that estimate considered only unintentional shootings, which have lower costs than assaults. The figure

for inpatient quality of life losses are in line with findings by Petersen et al. (2020), which estimate that these tend to be four to seven times medical costs. Inpatient medical costs are similar to those found in a recent GAO report (2021).

Work loss estimates are lower in this report compared to the CDC WISQARS estimates. However, the estimates here account for the fact that some have lower probabilities of working than others (i.e. those under 18 or over 65 years of age). Estimated days of work lost are in line with BLS estimates for worker days lost for firearm injuries (50 days for assault by firearm; 30 days for accidental firearm injuries).

Firearm Injuries with Ongoing Care & Paralysis

The previous sections focused on costs and prevalence associated with new firearm injuries and initial visits to inpatient or outpatient facilities. However, a significant number of individuals require additional visits for ongoing care. A smaller group of individuals experienced multiple firearm-related injuries over the six-year timespan study (see Figure 15). The PHC4 data allows for more in-depth analysis of those individuals who received care on multiple visits, either for a single injury requiring follow-up care or for multiple injuries occurring over time. ICD-10 diagnosis codes designate whether a patient is receiving initial care for a firearm injury, subsequent treatment for some previous injury, or is receiving care for a complication that arose as a direct result of a previous injury (a sequela encounter). This section analyzes the costs and characteristics of injuries for individuals differentiating those with multiple injuries and/or follow-up care.

FIGURE 15: Distribution of Patients with Firearm Injuries
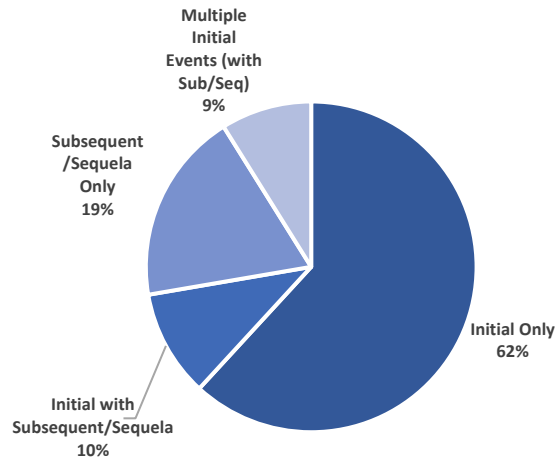
Notes: Analysis of 7,628 unique individuals between suffering firearm injuries from 2016-2021.

TABLE 3: Comparison of Visits, Stay Length, and Costs, by Reason of Injury

| | Single Visit | Multiple Visits | | |
	Initial Only	Initial with Subsequent/Sequela	Subsequent, Sequela Only	Multiple Initial Events (with Sub/Seq)
Reason for First Visit: Assault				
Number of Visits	1.0	2.4	1.7	2.5
Total Days Stayed	6.3	30.0	13.0	20.0
Multiple Surgeries	34%	50%	13%	34%
Total Medical Costs	$ 27,164	$ 82,447	$ 26,340	$ 67,253
Average Cost per Visit	$ 27,164	$ 35,084	$ 15,917	$ 25,491
n	2,355	365	424	235
Reason for First Visit: Accident				
Number of Visits	1.0	2.5	1.8	2.5
Total Days Stayed	4.1	25.0	14.0	13.0
Multiple Surgeries	23%	33%	11%	22%
Total Medical Costs	$ 18,460	$ 70,099	$ 27,226	$ 50,228
Average Cost per Visit	$ 18,460	$ 28,475	$ 13,080	$ 18,857
n	2,362	433	1,011	443

Notes: Analysis of 7,628 unique individuals between suffering firearm injuries from 2016-2021.

Across these four groups, Table 3 shows how medical costs increase with additional visits. Comparing the first two groups, one initial visit only vs. an initial with follow-up, severity for assault injuries is higher in the second group based on a greater percentage of multiple surgeries (50 vs. 34 percent). The total number of days stayed is five times higher (30 vs 6.3 days) and total medical costs are over 3 times higher ($82,447 vs. $27,164).

The third group consists of those coming in only for follow-up care – perhaps related to an injury that occurred before 2016 or one that was incorrectly coded as subsequent or sequela (vs. initial). A lower percentage require multiple surgical procedures during a single stay and the cost estimates are lower that other groups.

Nine percent of individuals who experienced an injury were injured multiple times over the timeframe.

TABLE 4: Total Economic Costs of Firearm Injuries, Single vs. Multiple Visits

	Initial Only	Initial with Subsequent, Sequela	% Increase
Medical Costs	$ 19,426	$ 71,561	3.68
Work Loss	$ 3,929	$ 14,701	3.74
- Days Lost	36	131	3.64
Home Production Loss	$ 730	$ 2,951	4.04
Quality of Life Loss	$ 99,391	$ 364,936	3.67
Total Economic Loss	$ 122,769	$ 451,254	3.68
% Assault	51%	47%	
n	3,185	598	

Notes: Analysis of those with an initial injury from 2016-2019 along with potential follow-up visits after 2019 (*n* = 3,783).

Further insight can be gained by focusing only on new injuries and grouping patients by those who only received care from the initial visit versus those that returned for subsequent/sequela care. Table 4 extends the comparison between the first two groups above, but restricts the timeframe for initial injuries to those that occurred before 2020 while counting subsequent/sequela visits after that time. For instance, someone who initially came into the hospital at the end of 2019 and had a subsequent surgery in 2020 would be included in the 2nd group.

From 2016 to 2019, 15.8 percent of patients (598/3,783) with new firearm injuries returned for additional care. As seen in the previous table, these injuries do tend to be more serious. However, it is possible that people with no insurance or costly coverage may forgo additional care – 8 percent of those in the first group (initial visit only) were uninsured compared to only 3 percent of those who returned for additional care.

Overall, individuals with subsequent care have 3.68 times the medical costs of those with only one visit and 3.68 times the total economic loss. On average, individuals in this group experience an estimated $451,254 economic loss from ongoing care due to a firearm injury. Approximately 5 percent of individuals with one visit will incur over half a million dollars in economic losses compared to 30 percent of those with additional subsequent care will incur over half a million in total losses; more than one in 10 (12 percent) people with subsequent care for firearm-related injuries incur costs exceeding $1 million.

TABLE 5: Total Economic Costs of Firearm Injuries, by Paralysis Diagnosis

	Paralysis in Diagnosis	No Paralysis Diagnosis	% Increase
Visits	3.60	1.17	3.08
Span between visits (quarters	4.29	0.24	
Total Stay	58.07	6.84	8.50
Stay per Visit	18.09	5.37	3.37
Medical Costs	$ 108,259	$ 25,005	4.33
Work Loss	$ 25,694	$ 4,969	5.17
Home Production Loss	$ 5,178	$ 946	5.47
- Days Lost	212.8	43.0	4.94
Quality of Life Loss	$ 558,175	$ 127,595	4.37
Total Economic Loss	$ 692,212	$ 157,594	4.39
n	121	3,662	

Notes: Analysis of those with one initial injury from 2016-2019 (*n = 3,783)*. Paralysis diagnoses include paraplegia (complete or partial paralysis in both legs) and quadriplegia (paralysis in all four limbs).

An additional level of severity involves paralysis, measured here as those diagnosed with paraplegia or quadriplegia. Looking at the same group of individuals who experienced an initial firearm injury between 2016 and 2019, approximately 3 percent (121/3,783) resulted in paralysis. Individuals who are coded with an additional paralysis diagnosis experience 8.5 longer stays, 4.33 times higher medical costs and 4.39 higher economic losses.

This group experience an average economic loss of $692,212, which is likely a lower bound for the losses that is actually incurred. This only estimates the costs over the span of treatment, which is an average of one year for those diagnosed with paralysis. Ongoing work and quality of life losses, as well as additional societal costs of long-term unemployment and disability benefits, would need to be added to this figure. However, this estimate is in line with those reported by the National Spinal Cord Injury Statistical Center (NSCISC), which found the first year of losses for paraplegia are close to $600,000 and $70,000 for each subsequent year. Lifetime costs of paralysis may grow to well over $2 million for someone who experiences a severe firearm injury.

Multivariate Analysis

A final analysis seeks to identify the factors associated with longer inpatient stays and increased medical costs due to firearm injury. Also, factors associated with an injury being due to assault or accident are analyzed.

Figure 16 shows these significant factors, controlling for other important variables related to the injury, including number of procedures, year, and county. Bars moving from 0 percent to the right indicate that the listed factor has a higher percentage stay/cost compared to its reference group. For instance, males have 4.2 percent longer stays and 8.5 higher costs than females, controlling for other variables.

We see that visits billed to Medicaid and Medicare tend to result in longer stays (compared to private insurance), while those billed directly to uninsured patients result in lower stays. This is suggestive of healthcare service rationing by the patient – when the out-of-pocket costs of care increase (either due to large co-pays/deductibles with private insurance or due to being uninsured), a patient is less likely to be able to afford additional care. Visits billed to Medicare are 4 percent less costly than those billed to private insurers while those billed to uninsured patients directly are 6.5 percent lower. Again, it is possible that those without insurance choose to forego procedures and services due to having to pay out-of-pocket.

Controlling for other factors related to injury severity, including procedures/surgeries performed and number of procedures, assault injuries require a 12 percent longer stay and are 12 percent costlier than accidental injuries. The results based on gun type suggest that injuries due to larger guns (i.e. rifles and shotguns) have longer stays but lower costs – this is possible because injuries involving large guns happen disproportionately to white patients (who have Medicare, 20 percent vs. 7 percent of Black patients). Also, injuries due to larger guns are disproportionately due to accident.

## FIGURE 16: Factors Associated with Hospital Stay Length and Cost
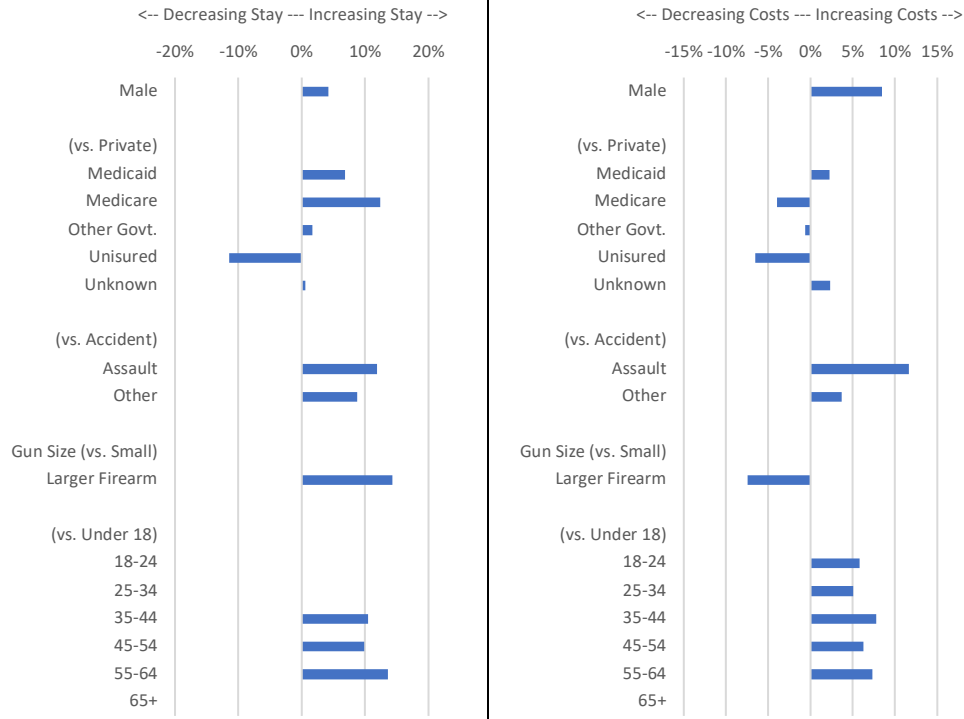
16a: Length of Hospital Stay

16b: Cost of Stay

Notes: Analysis of initial injuries, *n = 9,352*. Estimated using regression analysis, controlling for the variables shown, along with race, procedure count, county, ICD PCS procedure code, quarter, and year. Bars moving to the right indicate that that factor is associated with higher stay length (left) or cost of medical care (right), compared to its reference group (indicated in parenthesis). Bars moving to the left indicate lower stay length and costs vs. the reference group.

In sum, injuries to male patients and injuries due to assault are associated with both longer length of stay and higher medical costs. Injuries billed to Medicaid and Medicare are associated with longer stays while those billed to the patient directly (uninsured) are associated with shorter stays. Race of the patient was not related to either stay length or cost. Length of stay, care from an inpatient facility, and number of procedures are all associated with higher costs of care.

FIGURE 17: Factors Associated with an Injury Being Due to Assault or Accident

17a: Factors Associated with Assault

17b: Factors Associated with Accident
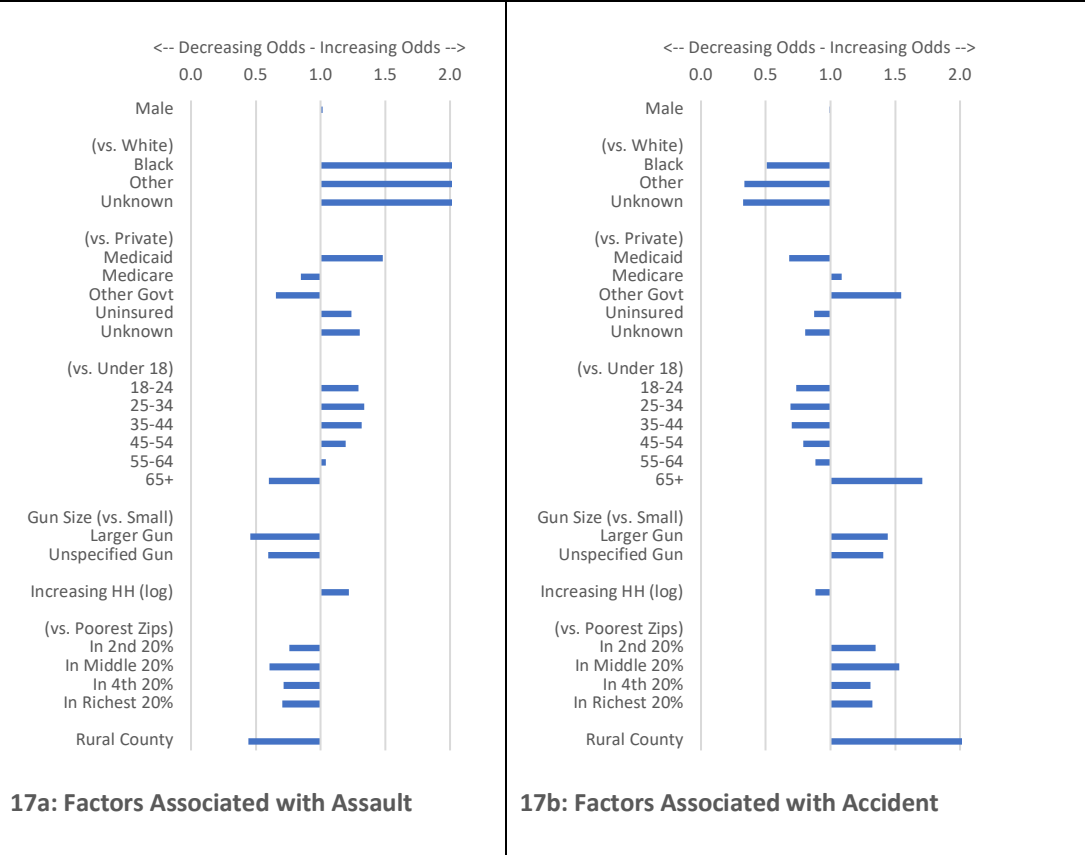
Notes: Analysis of initial injuries, *n = 9,352.* Estimated using logistic regression, controlling for the variables shown, along with quarter, and year. Bars moving to the right indicate that factor is associated with higher odds of the injury being due to assault (left) or accident (right), compared to its reference group (indicated in parenthesis). Bars moving to the left indicate lower odds vs. the reference group.

Additional analysis was performed to identify pre-injury factors associated with an injury being either due to assault or accident. Among the group of people with a firearm injury, this analysis identifies which individual and location factors related to an injury being due to assault.

Figure 17 shows that a number of variables have a strong relationship to the reason for injury, with bars moving to the right of 1 indicating that the listed category has higher odds of assault/accident compared to its reference category.

Among gun-injury victims, gender is not associated with either assault or accident, race is strongly associated.[3] Non-white patients had more than twice the odds of having an injury due to assault than white patients (while the opposite is true for accidents). The use of Medicaid to pay and direct payment due to being uninsured are both associated with higher odds of assault injury.

Patients between the ages 18 and 44 have the highest odds of an injury being due to assault. Additionally, zip code and location suggest additional effects – higher population in the zip code is related to higher odds of an injury being due to assault. Higher average incomes in the zip code are associated with lower odds of assault, as is being in a rural county.

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[3] This does not suggest that males and females have the same likelihood of being assaulted with a firearm in the general population – males have much higher assault rates overall. What is being estimated is whether male patients are more likely to be receiving care due to an assault (vs. an injury) than female patients. Since males are much more heavily represented in the data as being injured due to both assault and accident at similar rates (90 percent of each are male), the multivariate results do not find an association.

Technical Appendix

All costs are adjusted for inflation and presented in 2020 dollars. Medical costs were adjusted using the Consumer Price Index for Medical Care and other economic costs were adjusted by the CPI for all urban consumers. As with many sources of inpatient and outpatient cost data, PHC4 reports individual visit charge amounts – amounts charged to an individual patient or their private or public insurance provider. However, charged amounts are rarely the same as what is actually paid to the provider. Healthcare cost studies typically adjust charge amounts by a cost-to-charge ratio (CCR) for the hospital. Hospital-specific Medicare CCRs from the Center for Medicare and Medicaid Services (ranging from 0 to 1) were multiplied to all PHC4 charge data (CMS, 2022b).

Economic costs due to lost days of paid employment are limited to estimates of wage/salary income, adjusted for the probability of employment. Mean income figures for Pennsylvania Zip-Code Tabulation Areas were taken from the U.S. Census. These mean incomes were adjusted for gender, race/ethnicity, and age earnings differences using regression analysis of employed workers in Pennsylvania from the American Community Survey (ACS). Probit regression on all persons in the ACS were run to estimate the probability of employment based on gender, race, and age-group. An individual's estimated work income is then based on the mean income of their Zip Code, adjusted for earnings differences based on gender/racial/age, and multiplied by the individual's probability of being employed, also based on gender/race/age differences. Individuals younger than 16-years-old and older than 65-years-old are assumed to be out of the labor force and lost income due to work is set to zero.

Days lost due to injury are based on length-of-stay figures in the PHC4 hospital stay data added to estimates for additional recovery time. Recovery time is estimated based on severity of injury, proxied by hospital length of stay. Using the patient PHC4 data, the natural logarithm of length of stay was regressed on patient gender, race, age, payment provider, ICD-10 diagnosis code, gun type, procedure count for the stay, and ICD-10 PCS procedure codes to estimate a range of injury severity. This predicted severity was factored to correspond to BLS reports on the number of days away from work for intentional and non-

intentional injuries, including shootings (a median of 50 days lost for intentional shootings by another person; median of 30 days work lost for unintentional shooting injuries) (US BLS).

Lost days of household work is included in this study, as in Lawrence's (2000) estimations of injury costs. Kanal & Kornegay (2019) found that the inclusion of "home production," which is the estimated value of time spent cooking, cleaning, childcare at home, and other home-based activities would raise nominal GDP by 26 percent. This percentage multiplied by Zip Code mean income is used to approximate home production, differentiated by gender differences found in Kanal & Kornegay (2019).

Intangible losses from pain, suffering, and lost quality of life are typically assigned a monetary value in injury cost studies. Peterson et al. (2021) used cost data from the CDC Web-based Injury Statistics Query and Reporting system (WISQARS) to estimate of injury costs in 2019, including medical, economic, and quality of life costs. To create an estimate of these intangible costs, quality-of-life loss estimates are divided by medical costs for various age groups and by gender, as reported in Peterson et al. (2021). These age- and gender-specific multipliers are then applied to PHC4 medical cost data to create quality of life loss estimates for the current study.

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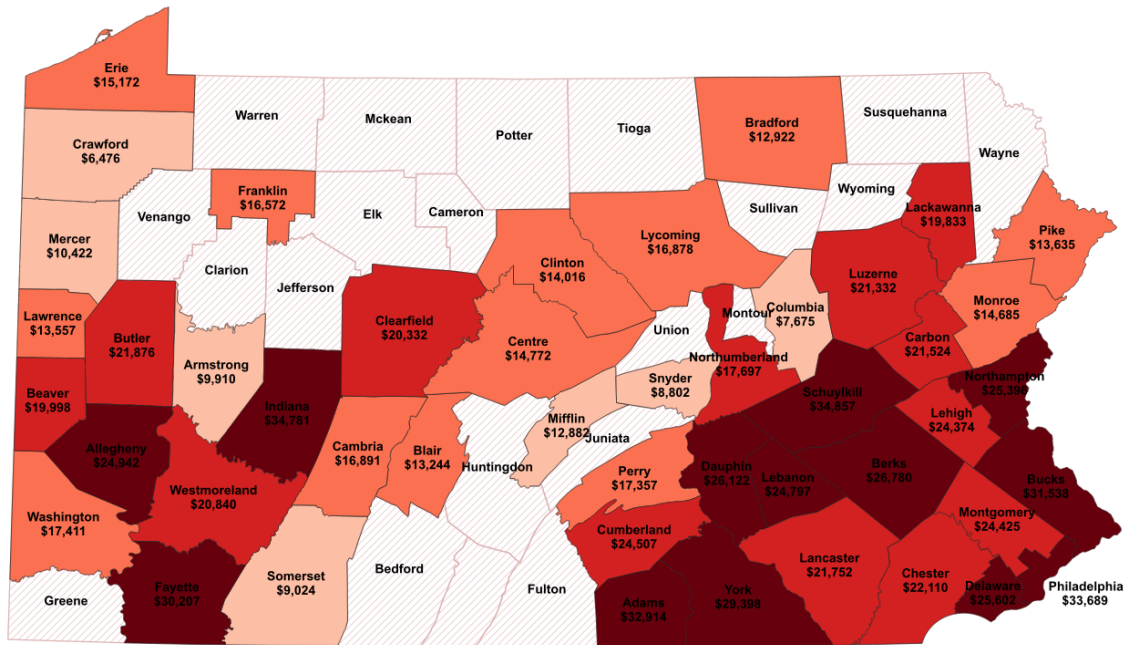
County Maps

The following maps are presented below:

- Five-year total injury medical costs
- Injury average costs
- Five-year total injuries
- Injury rates per 100,000 persons (averaged over 5-years)

## MAP 1: Firearm Injury Medical Costs by County (Five-year)
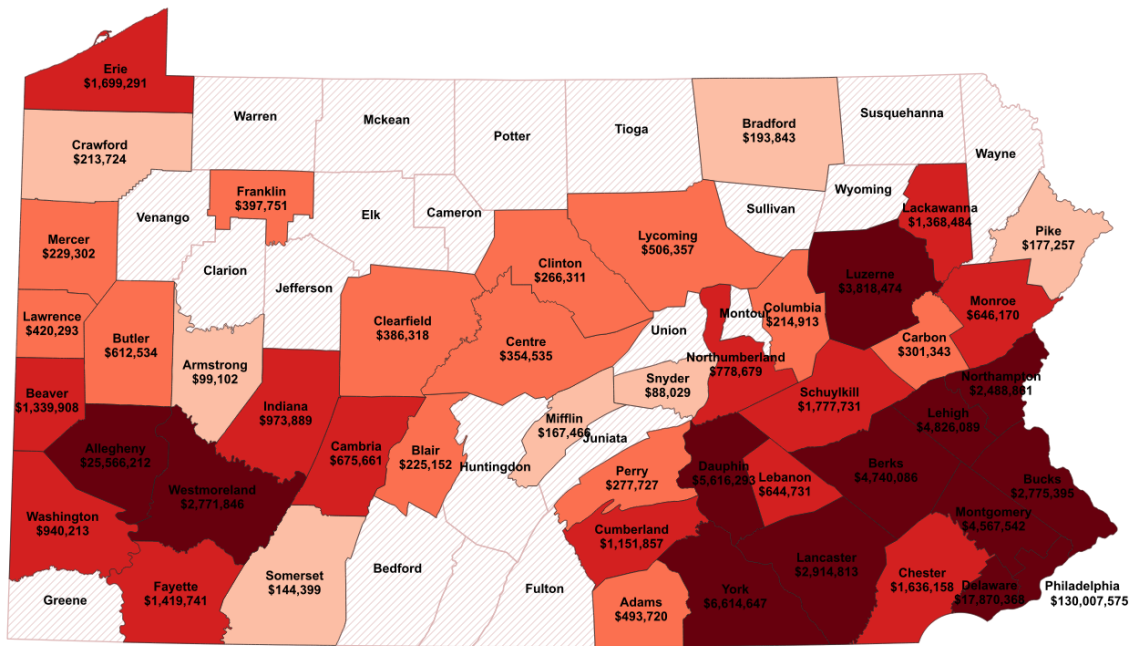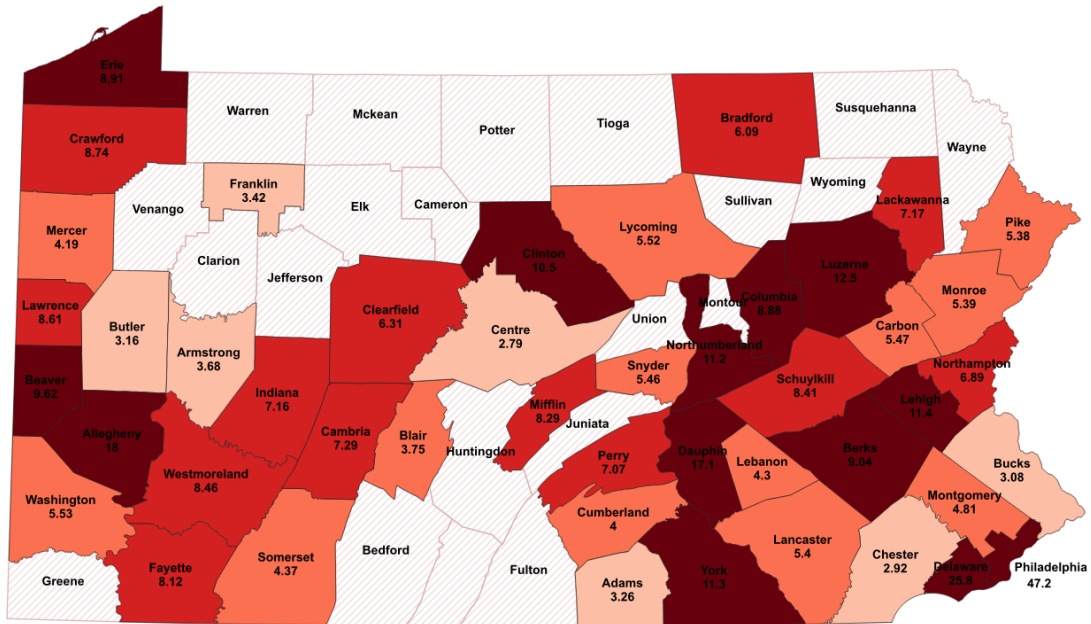

1a: Five-year Medical Cost Totals

1b: Medical Cost, Average per Injury

Notes: Results were withheld for counties that had less than 10 injuries in the data. Lighter colors represent the 25 percent of counties with the lowest total and average costs; darker red represents counties with highest total and average costs.

MAP 2: Firearm Injuries by County (Five-year)
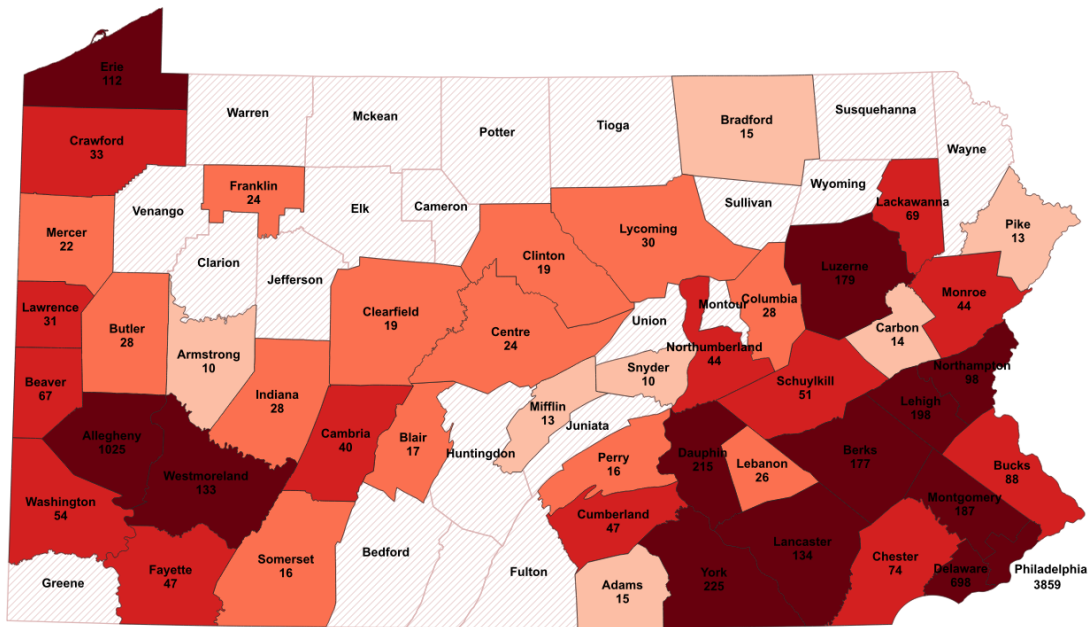
2a: Five-year Totals

2b: Yearly Injury Rates, per 100,000

Notes: Results were withheld for counties that had less than 10 injuries in the data. Lighter colors represent the 25 percent of counties with the lowest total injuries and injury rates; darker red represents counties with highest total injuries and injury rates.