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Abstract

Since the dramatic surge in violent crime among youth that swept the country during the 1980s and 1990s, gun violence in U.S. cities has largely been treated as a young person's problem. Research and resources, along with media coverage, is often directed towards addressing gun violence among teens and young adults. However, has the age distribution of gunshot wound victims remained the same over time? Using data on all gunshot wounds (GSW) treated at Yale New Haven Hospital between 2003 and 2015, we explore trends in the age distribution of GSW victims in New Haven, Connecticut. Contrary to the prevailing framing of age and gun violence, we found that GSW victims in New Haven are 27 years old on average and have become *older* over time. Over the past thirteen years, the average age of GSW victims in the city has increased steadily from 23.9 to 27.6 years old. The upward trend in average age is seen across all racial groups, as well as for both fatal and non-fatal GSW incidents. Moreover, we find that while the average age of black GSW victims increased about two years over the study period (from 24.4 to 26 years old), the average age of Hispanic and white GSW victims increased nearly eight (from 21 to 28.7 years old) and nine years (23 to 31.5 years old), respectively. The findings suggest a need to understand age and urban gun violence from a more nuanced perspective that takes into account longitudinal trends and racial disparities.

BACKGROUND

Gun violence in the United States is often portrayed and treated as an issue primarily involving youth. Media coverage on gun violence regularly features young victims.[1-2] Many policies and programs at the federal, state, and local levels are specifically focused on preventing gun violence among youth.[3] For example, the Cure Violence Program in Chicago seeks to prevent gun violence among "high risk" youth between the ages of 16 and 25 through street outreach programs, community mobilization, and public education.[4] Similarly, the Safe Streets Program in Baltimore employs street outreach workers to address gun violence among youth between the ages of 15 and 24, while the Street Outreach Workers Program in New Haven utilizes a public health risk reduction model with the goal of reducing violence among teens and young adults between the ages of 13 and 35.[5-6]

The emphasis on youth in gun violence prevention efforts is certainly well-founded. Gun violence among youth assumed a prominent role during the surge in violent crime that swept the United States during the mid-1980s to early 1990s. Indeed, in a study of trends in youth violence, Philip J. Cook and John H. Laub found that an acute increase in gun violence among youth was, in part, responsible for the dramatic rise in violent crime during this period.[7] They observed that involvement in violent crime was markedly higher among youth compared to other age groups during the 1980s, as homicide commission rates among youth under the age of eighteen "more than tripled between 1984 and 1993."[7] Cook and Laub noted that the "epidemic of youth homicide was entirely a gun-homicide epidemic," as verified rates of homicide not involving guns "remained essentially unchanged" for this age group during this period.[7]

Moreover, while violent crime in the United States has declined steeply since its peak in the early 1990s, rates of gun violence remain high, particularly among youth. In 2013, 33,636 Americans died due to injury by firearms, including homicides, suicides, and accidents; this means that on average in 2013, more than 90 Americans died due to firearm injury every day.[8] Individuals between the ages of 15 and 24 were prevalent among these figures, accounting for one-third of all deaths due to gun homicide and nearly one-fifth of all deaths due to any type of firearm injury.[8] In fact, the rate of gun homicide is 8.4 per 100,000 population for individuals between the ages of 15 and 24, which is the highest rate among all age groups and more than double the national rate.[8]

It is evident that gun violence among youth is a public health problem in demand of our utmost attention. However, have the victims of gun violence remained young over time? This paper begins to answer this question by describing trends in the age of gunshot wound victims in New Haven between 2003 and 2015 using hospital trauma registry data. New Haven has experienced rates of violent crime comparable to that of other mid-sized cities, which saw a dramatic rise in violent crime during the 1980s and early 1990s that was followed by a marked decline in violent crime during the mid- to late 1990s.[9-11] By exploring trends in the age of gunshot wound victims in New Haven over the past thirteen years, this paper provides useful analytical insight towards understanding how the legacy of youth violence in preceding decades currently shapes our perceptions of and policies towards age and gun violence in U.S. cities.

DATA

This paper analyzes data on all fatal and nonfatal gunshot wounds—including homicides, assaults, accidental injuries, and self-inflicted injuries—treated at Yale New Haven Hospital (YNNH) in New Haven, Connecticut between 2003 and 2015. YNHH is a nonprofit, academic medical center. As the only American College of Surgeons verified and Connecticut Department of Public Health designated Level I Trauma Center in the Greater New Haven area, YNHH assumes a key role in treating the city and region's gunshot wound (GSW) victims. YNHH also addresses the effects of local gun violence on community health through its participation in the Healthier Greater New Haven Partnership, a collaborative effort among public health, healthcare, government, and civic leaders to identify and respond to community health needs, as well as its sponsorship of the Greater New Haven Community Health Needs Assessment.[12]

YNHH maintains data on gunshot wounds and other trauma treated at its facilities using trauma registry software, TraumaBase (Clinical Data Management, Evergreen CO).[13] During the thirteen-year period between 2003 and 2015, a total of 1,225 GSW incidents involving 1,199 unique victims were reported.[14] Because nearly all victims in the sample experienced only one GSW incident, the analysis presented in this paper focuses on unique incidents rather than victims.[15] Each GSW incident record included data on the victim (e.g., name, age, race, gender, and address) and his/her injury (e.g., date, description, diagnoses, complications, severity score, probability of survival, disposition from emergency department, and discharge status). The analysis describes trends across these 1,225 GSW incidents based on year, race, gender, fatality, and age.[16]

In the proceeding analysis, GSW incidents refer to those injuries treated at YNHH between 2003 and 2015. While the majority of GSW incidents that occurred in New Haven during the study period were treated at YNHH, there were GSW incidents that were not treated at YNHH and therefore are not present in the data. GSW incidents in which individuals died on scene and were never transported to YNHH or individuals who were shot and did not seek treatment at YNHH are not captured in the data. These untreated GSW incidents are reflected in the differences between the annual number of GSW incidents reported by YNHH and the annual number of gun assaults and homicides reported by the New Haven Police Department (NHPD). For example, in 2013, while NHPD reported 71 gun assaults and 19 gun homicides, YNHH reported treating 69 GSWs with 14 of those being fatal. Although data on GSWs treated at YNHH do not definitively capture all GSW incidents that have occurred in New Haven over the past thirteen years, the data nonetheless provide fairly robust information that can be used to understand the city's overall trends in gun violence.

REVIEW OF GUN VIOLENCE IN NEW HAVEN

New Haven, Connecticut is a mid-sized city with a population of 129,779, a population total that has remained steady for the past two decades.[17] The city is predominantly white (42.6%) and black (35.4%), with a growing Hispanic population (27.4%) that increased by one-third between 2000 and 2010.[17-18] The city is nearly gender-balanced, with a 48.2% male and 51.8% female divide.[16] The median age is 29, about eight years younger than the national average.[17,19] One in four (25.4%) of the city's residents are under the age of 18 and one in five (20.8%) are between the ages of 20 and 34.[17,19] New Haven has struggled with poverty in the post-industrial era with approximately one out of every four residents living below the poverty line, nearly double the national average.[20] The median income for a household is $37,508, which is significantly below the national median of $51,759.[20]

Among mid-sized cities in the United States, New Haven is often said to be one of the most dangerous.[21] This is an oversimplification of the city's history of crime. Between 1940 and the late 1960s, New Haven was below or on par with the national average for violent crime. The 1980s marked a sharp shift, as the city became poorer and struggled to contain crime. Gang violence and urban upheaval contributed to a surge in violent crime in the 1980s that doubled that of the national crime rates.[9] Mirroring national trends, the last decade before the turn of the century brought a drastic drop in violent crime in New Haven, from approximately 30 crimes per 1,000 residents in 1990 to 15 crimes per 1,000 residents in 2000.[10] In recent years, the city's crime trends have been mixed. While violent crime has generally stabilized, homicides dropped to a low in 2003 and have since increased steadily to rates on par with Chicago and Oakland, although decreasing again in recent years.[11]

In particular, there have been more shooting injuries in New Haven in recent years. As shown in Figure 1, GSW incidents treated at YNHH peaked in 2009 and then declined steadily until roughly 2013. Since 2013, GSW incidents treated at YNHH have begun trending upward again, with a total of 95 GSW incidents in 2015—nearly double the number of GSW incidents that occurred in 2003 (n = 57).

As it is in most U.S. cities—and despite a prevalent focus on gun homicides—most GSW incidents in New Haven are non-fatal. As such, the overall trend in GSW incidents in New Haven ebbs and flows with levels of non-fatal GSW incidents. The annual number of nonfatal GSW incidents treated at YNHH has ranged considerably from 41 to 126, with an average of about 83 nonfatal GSW incidents per year. In contrast, fatal GSW incidents treated at YNHH have ranged from three to 18, with an average of about 11 fatal GSW incidents per year. By and large, fatal GSW incidents have been mostly flat, with minor upticks and downticks, and with consecutive decreases since 2013. Overall, GSW incidents treated at YNHH reached a low in 2004 with 49 combined fatal and nonfatal GSW incidents and a high in 2009 with 138 total GSW incidents. From 2004 to 2009, YNHH saw consecutive increases in GSW incidents, with the exception of a slight decrease from 2006 to 2007. GSW incidents have relatively stabilized within the past few years, with an average of about 90 combined fatal and nonfatal GSW incidents per year between 2011 and 2015.

Also like gun violence in other cities, GSW incidents in New Haven are marked by important racial disparities. Table 1 shows that 68% of all fatal and nonfatal GSW victims treated at YNHH between 2003 and 2015 are black; Hispanics and whites account for approximately 16% and 14% of the remaining victims, respectively. Similarly, GSW incidents in the city are unequally distributed by gender. As seen in Table 2, GSW incidents occur overwhelmingly among males, accounting for 93% of all fatal and nonfatal GSW incidents that have been treated at YNHH over the past thirteen years.

Figure 1. Number of Fatal and Non-Fatal GSW Incidents Treated at Yale New Haven Hospital, 2003-2015

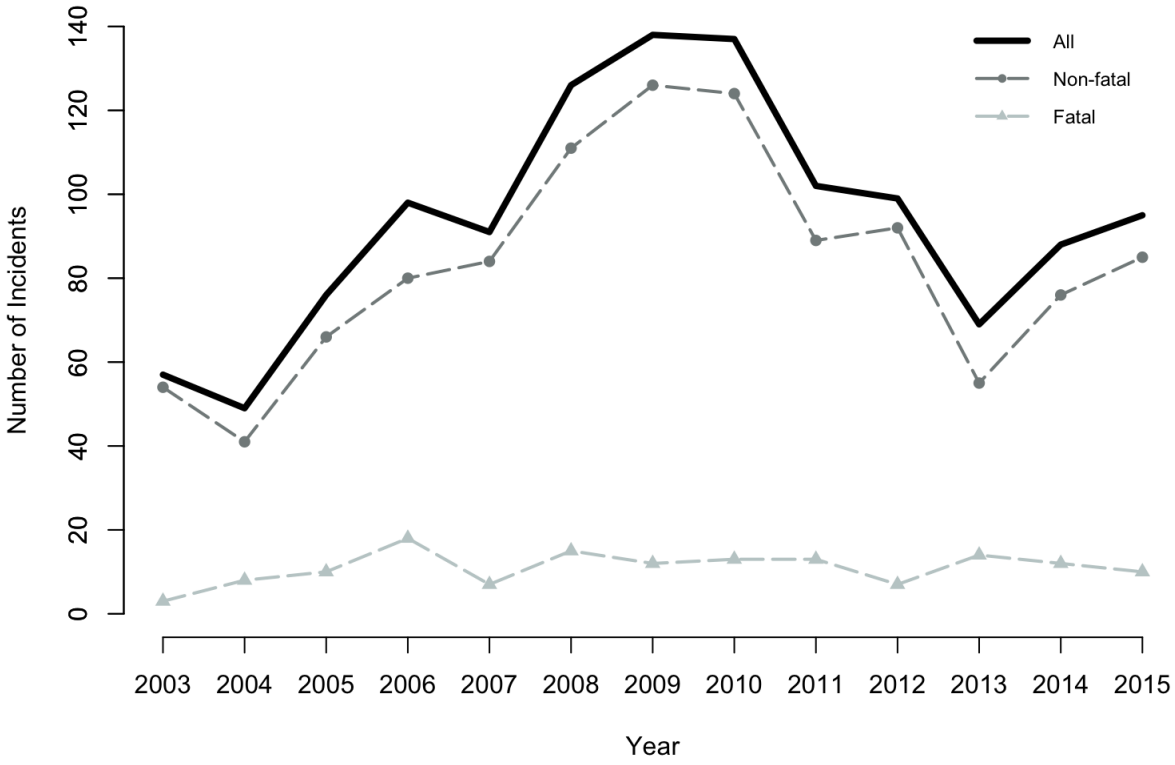


Table 1. Proportion of GSW Victims Treated at Yale New Haven Hospital by Race, 2003-2015

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	**All Years**
Black	77%	73%	54%	65%	68%	63%	73%	66%	75%	65%	72%	74%	62%	**68%**
Hispanic	7%	16%	26%	17%	18%	21%	17%	15%	10%	14%	7%	14%	16%	**16%**
White	16%	8%	17%	14%	14%	15%	9%	19%	15%	17%	14%	9%	16%	**14%**
Other	--	2%	--	1%	--	1%	--	1%	--	4%	3%	2%	6%	**1%**
No Data	--	--	3%	2%	--	1%	--	--	--	--	3%	1%	--	**1%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
N	57	49	76	98	91	126	138	137	102	99	69	88	95	1,225

Table 2. Proportion of GSW Victims Treated at Yale New Haven Hospital by Gender, 2003-2015

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	**All Years**
Male	91%	92%	95%	94%	97%	93%	92%	92%	95%	92%	93%	95%	89%	**93%**
Female	9%	8%	5%	6%	3%	7%	8%	8%	8%	8%	7%	5%	11%	**7%**
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
N	57	49	76	98	91	126	138	137	102	99	69	88	95	1,225

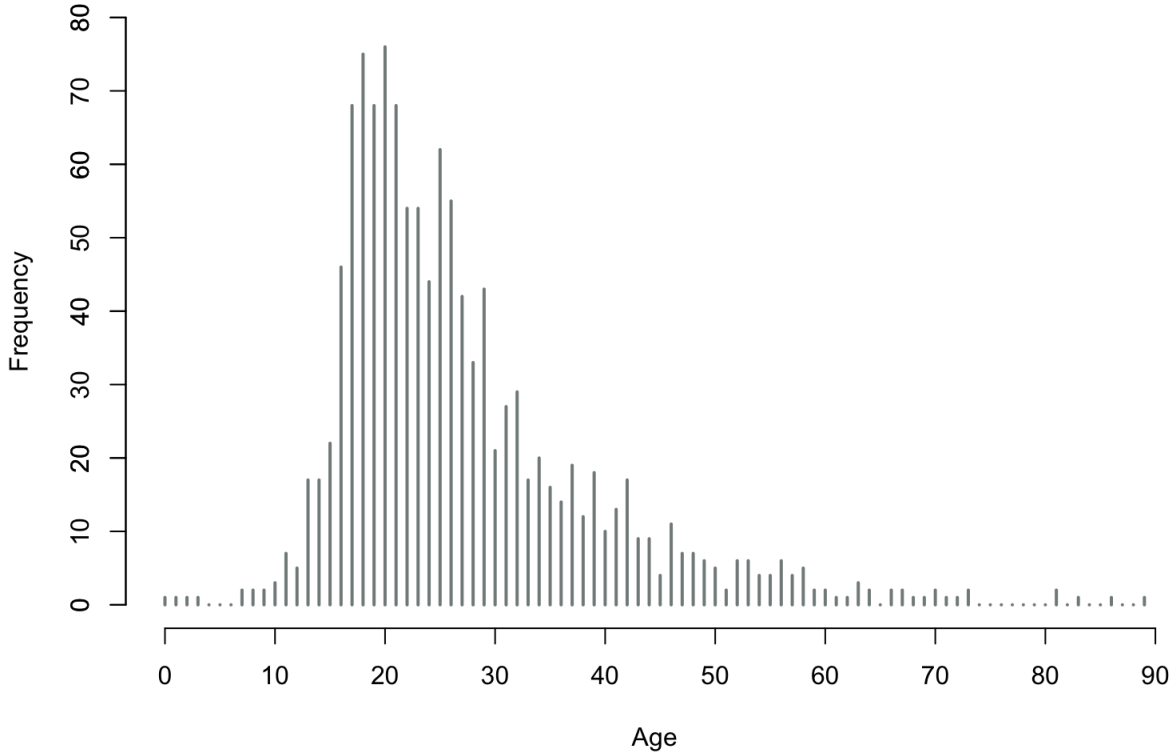
TRENDS IN AGE AMONG GUNSHOT WOUND VICTIMS IN NEW HAVEN

Given the city's relatively young population, to what extent are youth represented among GSW victims in New Haven? How does the age distribution of GSW victims vary by race or type of shooting? And, has the age distribution of victims remained stable over time? This section addresses these questions by first exploring the general age distribution of GSW victims treated at YNHH and then examining trends in GSW victims' ages over time.

General Age Distribution of Gunshot Wound Victims

Overall, GSW victims treated at YNHH range in age from less than one-year-old to 89 years old over the study period. The average age of a victim over the study period is 27 years old. Victims of fatal GSWs are, on average, four years older than victims of non-fatal GSWs; the average age of a fatal GSW victim is 31 years old as compared to 27 years old for non-fatal GSW victims. As seen in Figure 2, most GSW victims treated at YNHH over the past 13 years were between the ages of 19 and 32. Following a well-established pattern between age and crime, Figure 2 also shows that victimization peaks in the late teens to early twenties and generally declines from the late 20s onward.[22]

Figure 2. Age Distribution of GSW Victims Treated at Yale New Haven Hospital, 2003-2015



However, there are important differences in the age distribution of GSW victims treated at YNHH by race. Figure 3 displays the age of all GSW victims treated at YNHH between 2003 and 2015, disaggregated by race. Black and Hispanic GSW victims tend to be considerably younger than white GSW victims, with black victims being the youngest among all racial groups. Compared to white GSW victims, black victims are ten years younger and Hispanic victims are eight years younger on average; the average age of black, Hispanic, and white GSW victims is 25, 27, and 35, respectively. There is also greater variance in age among white GSW victims compared to black and Hispanic GSW victims. The vast majority of black and Hispanic victims are in their twenties, while most white victims are between the ages of 21 and 47.

The racial disparities in age are particularly pronounced in terms of fatal GSWs treated at YNHH. As seen in Figure 4, black and Hispanic victims of fatal GSWs are substantially younger than white victims of fatal GSWs. Relative to white victims of fatal GSWs, black victims of fatal GSWs are 19 years younger and Hispanic victims of fatal GSWs are 15 years younger on average; the average age of black, Hispanic, and white victims of fatal GSWs is 27, 31, and 46, respectively. While most black and Hispanic victims of fatal GSWs tend be in their twenties and early thirties, the majority of white victims of fatal GSWs are between the ages of 27 and 60. This pattern is striking given broader national trends indicating that the white-black gap in life expectancy has generally been decreasing over time (reaching a "record low" at 3.6 years in 2013), and that the Hispanic population has tended to have longer life expectancy on average compared to the U.S. population as a whole (81.6

versus 78.8 years in 2013).[8] Figure 4 also shows that the racial gap in age is noticeably smaller with non-fatal GSWs treated at YNHH. The average age of non-fatal GSW victims is 25, 27, and 33 for blacks, Hispanics, and whites, respectively.

Figure 3. Racial Differences in Age Distribution of GSW Victims Treated at Yale New Haven Hospital, 2003-2015

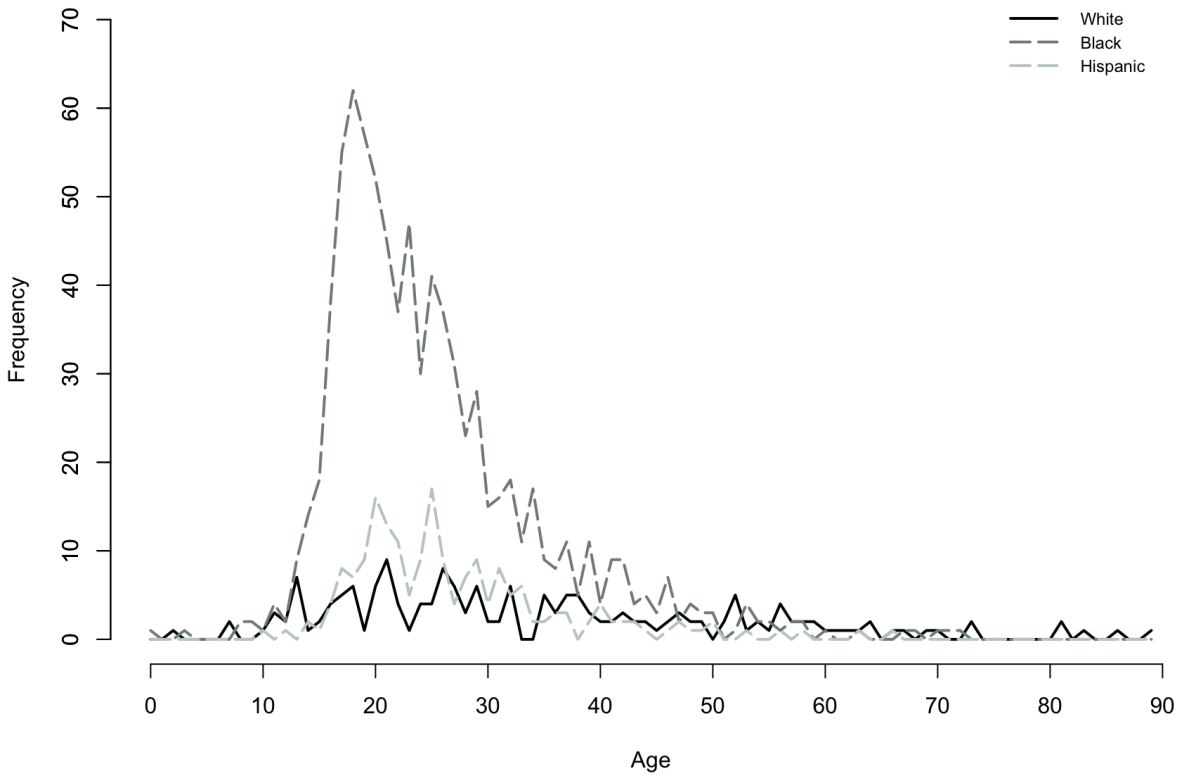
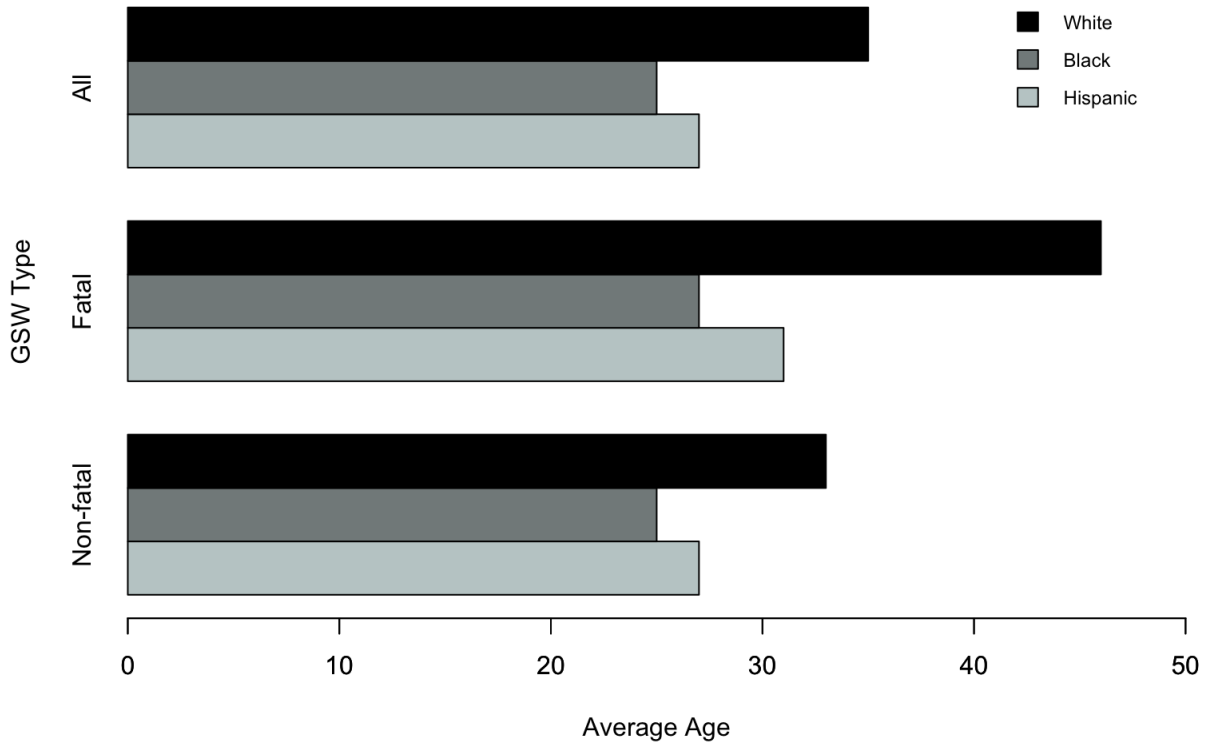


Figure 4. Racial Differences in Average Age of GSW Victims Treated at Yale New Haven Hospital by GSW Type, 2003-2015

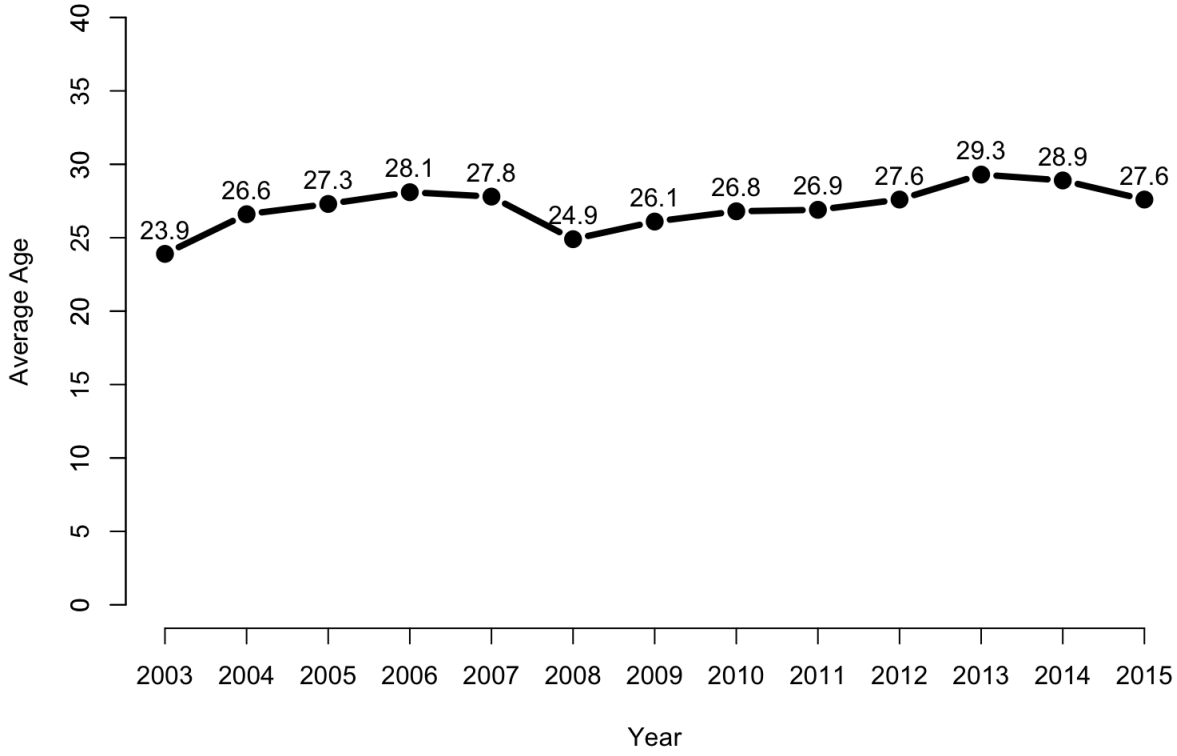


Age of Gunshot Wound Victims Over Time

Overall, the average age of GSW victims treated at YNHH has increased steadily over time. Figure 5 shows the average age of all GSW victims treated at YNHH for each year between 2003 and 2015. Over the past 13 years, the average age of GSW victims has overall increased from 23.9 to 27.6 years old. Average age inched upward each year between 2003 and 2007 before dropping considerably in 2008. Average age then resumed rising each year between 2009 and 2013, reaching the apex of 29.3 years in 2013. Although average age has decreased slightly over the past two years, the average age of GSW victims in 2015 at 27.6 years is still much older than that of most years in the past. The median age of GSW victims has similarly increased during this time, from 22 to 25 years old.

The upward trend in average age appears for both fatal and non-fatal GSW incidents treated at YNHH. Between 2003 and 2015, the average age of non-fatal GSW victims treated at YNHH increased from 24.4 to 27 years old. There were year-to-year increases in average age for all years during this period, with the exception of year-to-year decreases from 2006 to 2008 and 2013 to 2015. Similarly, the data indicate that recent victims of fatal GSWs treated at YNHH may be slightly older than those of years past. The average age of fatal GSW victims in 2015 was 32.4 years old, which was older than the average age for all but four of the preceding twelve years. However, it is important to note that because fatal GSWs occur relatively infrequently compared to non-fatal

Figure 5. Average Age of GSW Victims Treated at Yale New Haven Hospital, 2003-2015

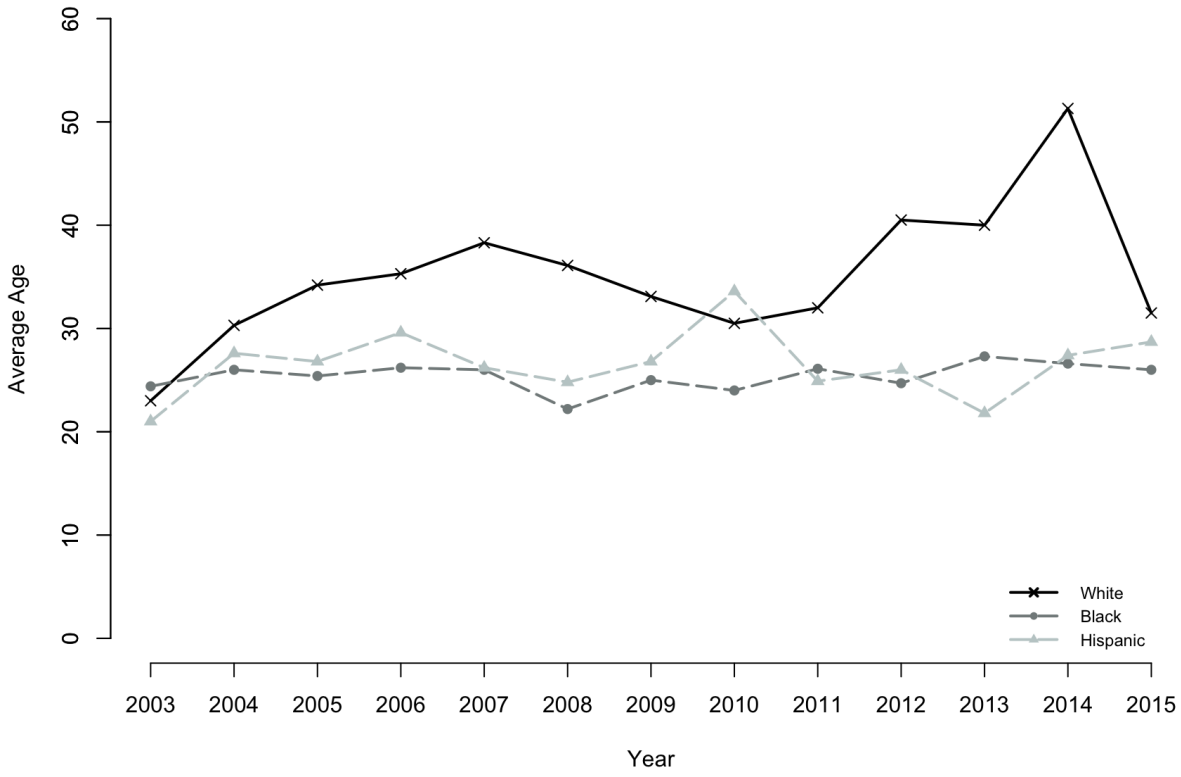


GSWs, trends in average age for fatal shootings are much more sensitive to the specific ages of victims in any given year.

The increase in the average age of GSW victims treated at YNHH is also seen across all three racial groups, though there is variation in the pace of change. Figure 6 displays the average age of white, black, and Hispanic GSW victims treated at YNHH for each year between 2003 and 2015. Over the past 13 years, the average age of white and Hispanic GSW victims has risen considerably relative to black GSW victims. While the average age of black victims increased about two years over the study period (from 24.4 to 26 years old), the average age of Hispanic and white victims increased nearly eight (from 21 to 28.7 years old) and nine years (23 to 31.5 years old), respectively.

As increases in the average age of white and Hispanic GSW victims have outpaced the increase in the average age of black GSW victims, there have been some changes in the age disparities between racial groups. Notably, the disparity in average age between white and black GSW victims has more than tripled between 2003 and 2015, increasing from 1.4 to 5.4 years during this period. The disparity in average age between white and Hispanic GSW victims has also grown slightly, increasing from 2.0 to 2.8 years over the same time period. In contrast, black and Hispanic GSW victims have become more similar in age over time, with the disparity in average age between the two racial groups decreasing from 3.4 to 2.6 years between 2003 and 2015. However, it is important to note that the age disparities between racial groups often fluctuate considerably from year to year. For

Figure 6. Average Age of White, Black, and Hispanic GSW Victims Treated at Yale New Haven Hospital, 2003-2015



example, the disparity in average age between white and black GSW victims increased consistently from 2003 to 2008, decreased consistently from 2009 to 2011, and then alternated between increasing and decreasing from 2012 to 2015. This underscores the value of looking at trends within and between racial groups over time to illuminate racial disparities and more broadly, the need to consider the continuously changing nature of gun violence as it relates to age and race.

DISCUSSION

Gun violence in U.S. cities is largely considered to be a young person's problem. Research and resources, along with media coverage, is often directed towards understanding and addressing gun violence among young people in their teens to early twenties. In contrast to this commonly-held view, our study of all gunshot wound incidents that have been treated at YNHH over the past thirteen years found that gunshot wound victims are considerably older. On average, GSW victims in New Haven were 27 years old. Nonfatal GSW victims were 27 years old on average, while the average age of fatal GSW victims was 31 years old. What's more, our study found that the average GSW victim in New Haven has gotten *older* over time. Between 2003 and 2015, the average age of GSW victims in the city increased from 23.9 to 27.6 years old—an increase of nearly four years. The

average GSW victim in New Haven is no longer an individual in their early twenties but rather an individual in their late twenties to early thirties.

Moreover, our study found that there are important racial disparities in the age of GSW victims in New Haven. Black and Hispanic GSW victims treated at YNHH were markedly younger and less varied in age than white GSW victims. The average age of black, Hispanic, and white GSW victims was 25, 27, and 35 years old, respectively, with most black and Hispanic victims being in their twenties and most white victims being between the ages of 21 and 47. This means that on average, nearly a decade separates when blacks and Hispanics tend to be victimized by gun violence compared to whites. These differences among racial groups in the average age of GSW victims have also changed over time. Between 2003 and 2015, the average age of white and Hispanic GSW victims in the city has increased much more rapidly than the average age of black GSW victims. One consequence of this is that the disparity in average age between white and black victims has more than tripled over the past thirteen years (increasing from 1.4 to 5.4 years). This suggests that increasingly, addressing gun violence in New Haven requires engaging individuals across different age *and* racial groups.

Our study is not without limitations. The study focused on the age of GSW victims only in the city of New Haven. Similar analyses of additional cities are needed to determine the generalizability of these findings, as well as to explore comparisons between cities that may vary in terms of their rates of gun violence, age distribution, and racial composition, among other factors. The study also focused on describing trends in age among GSW victims in New Haven; we have not unpacked the reasons as to *why* the average GSW victim in New Haven has become older over time and other trends have occurred. More research is needed to evaluate potential explanations such as the presence of an aging population or cohort effects. Our preliminary inquiries showed that the general population of New Haven has become slightly older over time. We also found that "repeat" GSW victims make up a very small proportion of all GSW victims in the city (n = 26 or 2% of all unique victims). All of these "repeat" GSW victims experienced two injuries and nearly all survived both injuries, with the amount of time between injuries being about 21 months on average and ranging from one month to over five years.

These limitations notwithstanding, our study demonstrates that delving into the age distribution of GSW victims—especially across age and racial groups and over time—can help provide new insight towards addressing a city's gun violence epidemic. Assuming that gun violence mostly affects youth and designing interventions and directing resources accordingly is not without basis, given the dramatic surge in gun violence among youth that swept the country during the mid-1980s to early 1990s. However, it is important to continuously evaluate the age targets of gun violence prevention programs and policies and to ensure that there is alignment between the age populations who are served by these initiatives and the actual age of gun violence victims.

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13. Trauma registry data maintained via TraumaBase (Clinical Data Management, Evergreen CO) was provided by Calvin Norway Jr., Medical Information and Technical Systems Coordinator at Yale New Haven Hospital.

14. Yale New Haven Hospital reported treating 1,226 incidents of firearm injury between 2003 and 2015. One incident was omitted from the sample because it represented an extreme outlier in age that was likely mistakenly inputted.

15. Ninety-eight percent of all victims in the sample experienced only one incident of firearm injury (n = 1,173 victims), while two percent of victims experienced more than incident of firearm injury (n = 26). Data on name, age, race, and gender were used to confirm that multiple injuries belonged to the same victim; data addresses were also used when available.

16. A binary variable indicating whether a firearm injury was fatal was created using data on the gunshot victim's disposition from the emergency department and discharge status. Any firearm injury in which either the disposition from the emergency department and/or discharge status was recorded as "Morgue" was coded as fatal.

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