

VIEWPOINT

HEALTH AND THE 2024 US ELECTION

Bullets as Pathogen—The Need for Public Health and Policy Approaches

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*Guns don't kill people. Bullets do.*Senator Daniel Patrick Moynihan, 1993¹

In our careers as emergency physicians and firearm violence researchers, we have interviewed and treated thousands of patients injured by bullets. We know what bullets do to human bodies: they tear through flesh, shred tissue and vital organs, and their destructive path leads to



Multimedia

bleeding, pain, shock, disability, and death. They leave permanent emotional scars and lasting mental health burdens on people who have experienced gun violence, families, and communities.

Despite best efforts, year by year the number of injured and killed grows. Bullets are now the leading cause of death of US youth, and more than 1.1 million firearm-related deaths occurred between 1990 and 2021.² Through examination of the devastating damage of bullets to individuals and society and application of public health principles akin to communicable diseases, we can prevent further injuries, disability, and unnecessary loss of life. It is past time to address the ultimate cause of injury and death, the bullet, and consider bullet-specific regulations to decrease the burden of firearm injuries in the US.

Bullets

Bullets come in various calibers (diameters) and masses and travel at velocities ranging from 800 to 3200 ft/s (244-975 m/s), or 545 to 2200 mph (877-3540 km/h). For reference, the speed of sound is 767 mph (1234 km/h). These factors provide a wide range of muzzle energy, a bullet's kinetic energy, which measures its destructive potential at the moment the bullet exits the barrel. A 9-mm handgun has a muzzle energy of 400 foot-pounds (ft-lb) (542 J). An AR-15-style weapon has a muzzle energy of 1300 ft-lb (1762 J).³ The mass school shootings of Sandy Hook, Connecticut; Uvalde, Texas; and Parkland, Florida, were all committed with the same type of bullet from the same type of AR-15-style rifle.

Bullets and Case Fatality Rate

In medicine, we understand the lethality of certain diseases by documenting the case fatality rate (CFR). The CFR is defined as the percentage of people who die from a specified disease among all individuals diagnosed with the disease over a certain period of time. For reference, the following is a list of CFRs for infectious pathogens: rabies, greater than 99%; untreated HIV, greater than 90%; smallpox, 30%; influenza, 0.1%; and chickenpox in children, 0.001%.

For firearms and their bullets, when used in a suicide attempt, the CFR is more than 90%, regardless of the age of the person who attempted suicide. In contrast, the CFR of a suicide attempt by in-

tentional overdose is 2% to 3%.⁴ Firearm homicides are a different story. A study of all firearm assaults in California from 2005 to 2019 calculated a CFR of 22% to 25%.⁵ Another study estimated that if all the people shot in assault-related shootings in Boston over a single year had been shot with lower-caliber handgun bullets, the fatality rate would have been reduced by almost 40%.⁶ The odds of dying when shot by a large- vs small-caliber bullet were 4-fold higher.

Bullets and Age-Related CFR

Bullets matter, and so does age. The CFR for the Sandy Hook mass shooting, which used a 5.56 NATO bullet with a Bushmaster rifle (an AR-15-style rifle), was 100% for the twenty 6- and 7-year-olds shot. No child survived this bullet once it penetrated their body. The 18-year-old killer at the Uvalde shooting also used an AR-15-style gun and carried 7 magazines with 30 bullets each, with the same bullet: 5.56 NATO. The CFR was 63% for the thirty 10- and 11-year-olds shot, lower than Sandy Hook, but many thousand-fold higher than the viruses that infect our young. Importantly, the perpetrator of the Uvalde mass shooting allegedly purchased more than 1600 bullets in a single online shopping purchase. The CFR for the Parkland mass shooting of the thirty-four 15- and 16-year-olds was 50%. It was the same type of bullet in each of the 3 shootings, each with differing (yet very high) CFRs and a clear correlation to age.

Illustrating the Damage of Bullets

The tissue trauma caused by bullets involves multiple factors, including the velocity, caliber, mass, design of the projectile, entrance profile (how the bullet enters the body), distance traveled and the tumble or yaw within the body, the biologic characteristics of the structures hit, and the mechanisms of tissue disruption (eg, stretching, tearing, crushing, cavitation, shock waves).⁷

The high-muzzle velocity bullets typically utilized in mass shootings create permanent and temporary impact cavities upon penetration. It is hard to envision what a permanent and temporary impact cavity means, so we have included an impact model video. This video uses ballistic gelatin to capture the effect of bullets traversing the equivalent density of muscle tissue to visualize the dynamics between lower- and higher-energy bullets and guns (**Video**). The first part of the video captures a .32-caliber bullet, a medium-muzzle velocity projectile (925-1100 ft/s [282-335 m/s]), shot from a handgun delivering a muzzle energy of 123 to 161 ft-lb (167-218 J). It primarily causes a permanent cavity, which is the space left by the crush and laceration of the tissues. The second part of the video shows a 5.56 NATO bullet, .223-caliber, high-muzzle velocity projectile (3251 ft/s [991 m/s]), shot from an AR-15-style rifle delivering a muzzle energy of 1300 ft-lb (1762 J), nearly 10-fold higher than the .32-caliber bullet. In addition to the permanent cavity,

these higher-velocity bullets create a pressure wave that forces the tissues away, causing a temporary cavity much larger than the bullet itself. The destructive potential is viscerally clear.

Recommendations for Bullets Rooted in a Public Health and Policy Approach

We need to apply public health principles to bullets, similar to how we conduct research and implement programs for infectious diseases. We need public policies to diminish the risk of bullets from entering humans by treating them as agents of injury and death, not as inert objects that do no harm. Based on this, we advocate for the following:

1. Enact purchase limitations by type of bullet and number purchased and increase the time from purchase to receipt. The Gun Control Act of 1968 regulated ammunition manufacturers, shipping, and purchasers. However, the Firearm Owners' Protection Act of 1986 reversed most of these regulations. The Law Enforcement Officers Protection Act of 1986 prohibits the manufacture and sale of armor-piercing bullets; exemptions are available.

2. Require licensure for ammunition dealers. Since 2018, California requires the sale of ammunition only through licensed firearm dealers, including ammunition purchased online, which must be shipped to local licensed dealers. The Stop Online Ammunition Sales Act of 2023 would require face-to-face purchases of ammunition, licensing of ammunition dealers, and reporting regarding bulk purchases of ammunition. As of October 30, 2024, it has not come up for vote.

3. Require background checks on each bullet sale, as performed in California, Connecticut, Illinois, Massachusetts, New Jersey, and New York. The Gun Violence Prevention and Community Safety Act of 2023 would set a minimum age of 21 years and require a license to purchase ammunition. As of October 30, 2024, it has not come up for vote.

4. Tax a bullet commensurate with its CFR, which applies a similar logic to higher taxes on items known to cause harm, such as cigarettes, alcohol, and e-cigarettes. Current tax rates, 10% on handgun ammunition and 11% on long gun ammunition, were set in 1955. In 1993, Senator Moynihan proposed graded taxation on bullets. As of July 1, 2024, California became the first state to apply an additional 11% tax on the purchase of firearms and ammunition through the Gun Violence Prevention and School Safety Act.

5. Develop a focused research agenda on how bullets impact humans to better understand the full dynamics of bullets and the differential effect of the wounds they inflict on children, teenagers, and adults.

6. Evaluate the cost, disability, and mental and emotional burden of those affected by bullets, including people who have experienced gun violence, families, and communities, to inform public health and policy.

Concerted efforts have minimized the destructive nature of communicable diseases and other known means of harm. We should and must do the same with bullets. Our children, families, and country depend on it.

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