Written testimony on HB23-1230, bans on common firearms

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The "findings" in HB23-1230 contain many false and deceptive statements.

Part I of this testimony examines some of the statistics in subsection (1). So-called "assault weapons" are used in fewer than 10% of mass shootings. The California legislature banned "assault weapons" in 1989, and the people of California today suffer from over one mass shooting per week.

Part II addresses the supposedly pernicious features of so-called "assault weapons." The features improve accuracy for every user for every shot. The features foster safe firearms use, especially for self-defense by persons with relatively weak upper body strength.

Part III examines in detail the bill's false claims about ammunition for "assault weapons." In truth, the ammunition for AR rifles is weaker than the ammunition for most other rifles.

Part I. Statistical data

> 18-12-601(1)(b) STATISTICS SHOW THAT IN EACH OF THE YEARS 2019, 2020, 2021, AND 2022, THERE WAS, ON AVERAGE, MORE THAN ONE MASS SHOOTING PER DAY

The bill's findings are coy about the sources of the purported "statistics" and "studies" about which it claims to be making findings. Not a single source is cited.

This means that the bill's proponents are not making actual "findings," as they might do if they read a study and found it persuasive. Instead, HB1230 merely transcribes what a lobbyist wrote.

The omissions do not indicate confidence that the bill's "findings" can withstand the sunlight of careful public examination.

Finding (b) might be silently referring to the "Mass Shooting Tracker" website, which uses a very expansive definition. According to that website, in 2022 there were 753 mass shootings nationwide. In California there were 57:

Dec. 15, Nov. 24, Nov. 12 (Sacramento), Nov. 12 (Indio), Nov. 6, Oct. 30, Oct. 16, Oct. 10, Oct. 8, Oct. 7, Oct. 3, Oct. 1, Sept. 28, Sept. 27, Sept. 23, Sept. 14, Sept. 13, Sept. 3, Sept. 2, Aug. 28, Aug. 21, Aug. 11, Aug. 3, Aug. 1, July 24, July 21, July 11, July 10, July 4 (Oakland), July 4 (Sacramento), June 17, June 12, May 29, May 28, May 20, May 17, May 15, Apr. 23, Apr. 17, Apr. 15, Apr. 10, Apr. 3 (S.F.), Apr. 3 (Sacramento), Mar. 26, Mar. 22, Mar. 10, Mar. 1, Feb. 28, Feb. 19, Feb. 12, Feb. 6, Feb. 2, Jan. 29, Jan. 27, Jan. 23, Jan. 9 (Fresno), Jan. 9 (L.A.)

The California general assembly enacted the nation's first "assault weapons" ban in 1989 and has expanded the ban many times. California has an average of more than one mass shooting per week.

(e) ASSAULT WEAPONS AND HIGH - CAPACITY MAGAZINES WERE DISPROPORTIONATELY USED IN PUBLIC MASS SHOOTINGS. OF THESE SHOOTINGS WITH KNOWN WEAPON TYPES, SEVENTY-SIX PERCENT OF THOSE INVOLVED AN ASSAULT WEAPON OR HIGH-CAPACITY MAGAZINE, COMPARED TO FORTY-FOUR PERCENT OF THOSE THAT INVOLVED A HANDGUN

The finding is not written coherently. It contrasts 44% "that involved a handgun" with 76% that "involved an assault weapons or high-capacity magazine." Many handguns use "high capacity magazines." The bill defines many handguns as "assault weapons," regardless of magazine size. So (e) provides no coherent data about whatever it is trying to ban.

Notice the extra word in subsection (e): "public." The rest of the bill uses the term "mass shooting," not "public mass shooting." The usage is how subsection (b) produces the claim of more than one mass shooting per day nationwide: by including shootings in private places, such private homes where one drug gang tries to rob another and there is a gun battle.

Mass shootings in any location account for about 2/3 of 1% of murders in the United States. According to the Congressional Research Service, under 10% of mass shootings in all locations involve "assault weapons." William J. Krouse & Daniel J. Richardson, *Mass Murder with Firearms: Incidents and Victims, 1999-2013*, Congressional Research Service (July 30, 2015) (9.78%, based on all mass shootings 1999–2013).

Why the switch in (e) to only "public"? To exaggerate the percentage of "assault weapons" involved. Public mass shootings are 21% of mass shootings. *Id.* at 14. In 1999–2013, perpetrators of the 66 *public* mass shootings used an "assault weapon" in 18 of them—27%. *Id.* at 29.

(h) THE DESIGN, FEATURES, AND PURPOSE OF AN ASSAULT WEAPON MAKE IT THE FIREARM OF CHOICE FOR MASS SHOOTERS;

This is false. "Assault weapons" are used in 10% of mass shootings overall, and in 27% of public mass shootings, as described above under finding (e).

A more accurate finding would have said:

> Ninety percent of mass shooters do not use 'assault weapons.' It is therefore unsurprising that in California, which has banned 'assault weapons' for over a third of a century, there is more than one mass shooting per week.

(k) RESEARCH SHOWS THAT BANNING ASSAULT WEAPONS LEADS22 TO A DROP IN MASS SHOOTINGS AND GUN MASSACRES ;

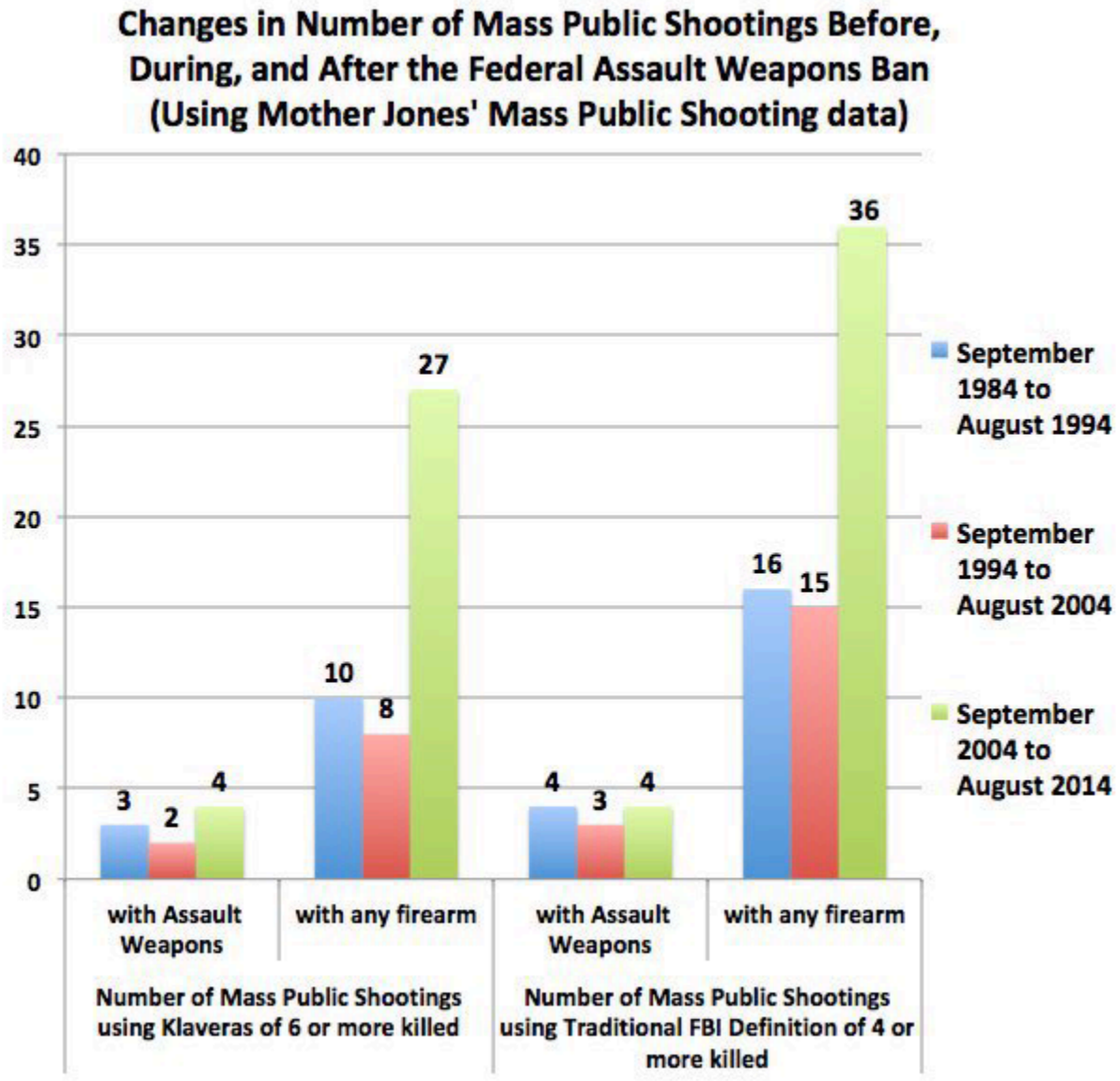
The research commissioned by the Clinton administration shows the opposite. In 1994, Congress enacted a ban with a 10-year sunset and ordered the Department of Justice to commission research on the effectiveness of the ban. President Clinton's DOJ chose the Urban Institute, a respected left-leaning think tank. The study found no discernable reductions in any metric of crime and violence. Christopher Koper, *An Updated Assessment of the Federal Assault Weapons Ban*, Report to the National Institute of Justice (Philadelphia: Jerry Lee Center of Criminology 2004).

(l) IN THE TEN YEARS THAT THE FEDERAL ASSAULT WEAPONS BAN WAS IN PLACE , GUN MASSACRES DROPPED THIRTY-SEVEN PERCENT. AFTER THE FEDERAL ASSAULT WEAPONS BAN EXPIRED IN 2004, GUN MASSACRES SKYROCKETED BY ONE HUNDRED AND EIGHTY-THREE PERCENT .

The proponents of HB23-1230 do not mention the Department of Justice study showing no benefits from the 1994 ban, even after ten years. Instead, they say that "massacres" went up after the ban expired. The word "massacres" is a term of art by professor Louis Klaveras, who is a professor at the Teachers College at Columbia University. He defines "massacre" as six or more killed. Many other scholars, and the FBI, define a "mass shooting" as four or more killed, not including the criminal.

Under either definition, the number *did* go up after the ban expired in 2004. However, almost all the increase involved guns that were *not* "assault weapons." The graph below shows the data. The Klavaras definition is on the left, and the standard definition is on the right.

As the data show, in every time period and under every definition, the large majority of mass shootings are *not* perpetrated with so-called "assault weapons."



Source: https://twitter.com/GodwinMeter/status/1641923528915296256

Part II. Features of so-called "assault weapons"

(1)(g) THESE FEATURES INCLUDE DETACHABLE MAGAZINES, BARREL SHROUDS, PISTOL GRIPS, FORWARD GRIPS, AND TELESCOPING STOCKS, WHICH ALLOW A SHOOTER TO EITHER CONCEAL THE WEAPON OR MAKE IT EASIER TO FIRE A HIGH VOLUME OF AMMUNITION IN A SHORT PERIOD OF TIME WHILE MAINTAINING ACCURACY.

Except for the detachable magazine, all of these features do improve accuracy under any condition. These include a single shot and multiple shots. The conditions include rapid fire against a group of home invaders, slow fire in a target competition, or a quick follow-up shot in hunting.

HB23-1230 claims to promote "public safety." Making firearms *less* accurate is the opposite.

Fourth Circuit Judge William B. Traxler was appointed to the Fourth Circuit by President Clinton in 1998. In a case involving a Maryland ban on "assault weapons," Judge Traxler wrote:

> The majority also suggests that other features of semiautomatic rifles like the AR-15 make them devastating military weapons. But several of the features identified do not make the firearms more lethal or battle-ready, but easier to use. On the contrary, many of the "military-style" components "increase accuracy and improve ergonomics." J.A. [Joint Appendix] 2100. A telescoping stock, for example, permits the operator to adjust the length of the stock according to his or her physical size so that the rifle can be held comfortably. J.A. 2182. Likewise, a pistol grip provides comfort, stability, and accuracy, see David B. Kopel, *Rational Basis Analysis of "Assault Weapon" Prohibition*, 20 J. Contemp. L. 381, 396 (1994) ("By holding the pistol grip, the shooter keeps the barrel from rising after the first shot, and thereby stays on target for a follow-up shot. The defensive application is obvious, as is the public safety advantage in preventing stray shots."), and barrel shrouds keep the operator from burning himself or herself upon contact with the barrel.[6] And although flash suppressors can indeed conceal a shooter's position—which is also an advantage for someone defending his or her home at night—they serve the primary function of preventing the shooter from being blinded in low-lighting conditions. See Kopel, at 397 ("Reduced flash decreases shooter's blindness—the momentary blindness caused by the sudden flash of light from the explosion of gunpowder. The flash reduction is especially important for shooting at dawn or at dusk."). None of these features convert a semiautomatic rifle into a weapon of war like a machinegun carried into battle by actual soldiers. It is unclear to me why features that make a firearm easier and safer to operate add to its battlefield prowess.[7]

> Footnote 6: These features, the majority suggests, enable a shooter to "spray-fire" rounds everywhere. "Spray-firing" can only be accomplished with a fully automatic assault rifle like an M4 carbine; "[i]n semiautomatic mode it is possible to either aim fire or to point shoot, but it is not possible to spray fire in the manner as one would in fully automatic mode." J.A. 2128.
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> Footnote 7: Nor does it appear that an AR-15-style rifle fires rounds that create a greater risk to civilians than rounds fired by a standard hunting rifle. In fact, just the opposite is true. The AR-15's standard .223/5.56 mm ammunition is "quite anemic in penetration capability and pale[s] in destructive capacity when compared to common civilian hunting rifles...." J.A. 2095.

Kolbe v. Hogan, 849 F.3d 114, 158-59 (4th Cir. 2017) (Traxler, J., dissenting). This definition, and some others below, comes from an opinion by

In the *Kolbe* case, Judge Traxler was writing for the dissent. Later, the U.S. Supreme Court vacated and remanded a successor case that had been based entirely on the *Kolbe* majority precedent. *Bianchi v. Frosh*, 858 Fed. Appx. 645 (4th Cir. 2021), vacated by 142 S. Ct. 2898 (2022) (Mem.). In light of the Supreme Court's decision in the Maryland gun ban case, Judge Traxler's opinion may be considered as an accurate statement of the law today.

Notably, HB23-1230 never acknowledges the legitimacy of defensive or recreational firearms use. Features that improve firearms ergonomics are important for all lawful uses of firearms, whether the user fires one shot or more shots.

Using a firearm safely means keeping it as steady as possible. Good ergonomics improve steadiness at every point of contact for the user. The adjustable stock helps a good, firm fit at the shoulder. Other grips provide a more secure, steadier point of contact for the trigger hand and for the forward hand.

Good ergonomics are especially important in self-defense situations. This is all the more true for persons with relatively weak upper body strength, including many women, many elderly, and many people with disabilities.

Part III. Ammunition

This Part is based partly on what I learned in writing the entry on "Gunshot Wounds" for the reference book *Forensic Science*, published by Salem Press. For over half a century, Salem Press had been a leading publisher of scientific reference books for libraries and academia.

According to HB23-1230:

> (1)(i) THE TYPICAL ASSAULT WEAPON BULLET LEAVES THE BARREL OF THE GUN THREE TIMES FASTER THAN A TYPICAL HANDGUN BULLET AND IS DESIGNED TO FRAGMENT AND TUMBLE. THE HIGH VELOCITY OF THE TYPICAL ASSAULT WEAPON BULLET DAMAGES AND DESTROYS TISSUE AS IT TRAVELS THROUGH THE BODY, CAUSING ORGANS TO BECOME LIQUEFIED AND CAUSING CATASTROPHIC INTERNAL BLEEDING.

The finding is a combination of half-truths and outright falsehoods. The bill claims that "assault weapon" bullets are exceptionally powerful. Just the opposite is true. The standard bullets for AR rifles are so small that the Colorado Department of Wildlife forbids their use for hunting "big game"—deer, antelope, or larger animals. The ammunition is only allowed for small game, such as coyote or smaller mammals.

The most common ammunition for AR rifles is .223. (The metric equivalent is 5.65mm). That is, the bullet's diameter is 223/1000ths of an inch. The bullet's weight in grains is typically 55 grains or 62 grains. (For weight in grains, 7,000 grains = 1 pound.)

Pursuant to Colorado Department of Wildlife regulations, the AR ammunition is too weak for big game hunting. The bullet must weigh at least 70 grains, and the caliber must be at least .24 (24/100ths of an inch). Colorado Dept. of Wildlife, Hunting Regulations, Big Game #203 (Mar. 15, 2023).

The experts at the Department of Wildlife believe that .223 is too weak to reliably take a deer or larger animal with a single shot.

Even if the Department of Wildlife is wrong, HB23-1230's "findings" are true, the bill still does not make sense. The finding would be in support of a ban on .223 caliber ammunition. Yet HB23-1230 does not ban ammunition. Instead, it bans many different firearms in a vast variety of calibers. A more carefully-written bill would have applied to only ammunition in .223—if finding (e) were actually true.

Below are two articles I wrote for *Reason* magazine about the power of .223 ammunition. In short:

- Rifle bullets are faster than handgun bullets. That is because rifles have longer barrels, so the expanding gas from the gunpowder pushes the bullet for a longer time in a rifle than in a handgun. The speed of .223 rifle bullets is similar to the speed of other bullets.

- In overall power, the .223 is lower than most other rifles, because its bullet is lighter.

- The .223 does not "tumble."

- The .223 fragments similarly to other bullets—when it hits a bone.

- Every bullet "damages and destroys tissue" and can "cause catastrophic internal bleeding." Compared to other rifle bullets, the .223 usually does so less, because of its small size and weight.

- The claim about "liquified" organs is preposterous. It is contrary to decades of studies by U.S. Army and other wound ballistics experts.

In the articles below, I bolded and italicized passages that most directly address the "findings" of subsection (1)(i).

Article 1. AR rifle ammunition is less powerful than most other rifle ammunition: Bullet speed matters, but so does bullet weight

by David Kopel & Gregory Wallace
Reason magazine, Volokh Conspiracy blog
April 11, 2023
[The Volokh Conspiracy is a law professor weblog founded by UCLA law professor Eugene Volokh. It has been cited in 65 federal and state judicial opinions.]

According to "assault weapon" ban proponents, the AR rifle's lethality is all about how fast its bullets travel. The *Washington Post* recently claimed that "what makes [the AR] so deadly is the speed of [its] bullet." "The higher speed of a bullet from an AR-15 causes far more damage after it hits the body and drastically reduces a person's chances of survival." Scott Pelley at CBS News declared that "the AR-15's high velocity ammo is the fear of every American emergency room." In a March 2023 order denying a motion for a preliminary injunction in *Delaware State Sportsmen's Ass'n v. Delaware Dep't of Safety and Homeland Security*, Judge Richard Andrews described how "intermediate-caliber rounds fired at high velocity" cause "catastrophic" wounds with "multiple organs shattered, bones exploded, soft tissue absolutely destroyed, and exit wounds a foot wide."

President Joe Biden repeatedly has exaggerated the velocity of AR bullets, most recently asserting that they travel five times as fast as handgun bullets. To prove that AR's pose an "exceptional danger," Judge Virginia Kendall claimed in her February 2023 order denying a preliminary injunction in *Bevis v. Naperville* that "[t]he muzzle velocity of an assault weapon is four times higher than a high-powered semiautomatic firearm."

This post will discuss the comparative velocity and kinetic energy of AR bullets and how those factors affect bullet penetration and wound severity. It is co-authored by Campbell University law professor Gregory Wallace, who has published two articles on "assault weapons," most recently *"Assault Weapon" Lethality*, 88 Tenn. L. Rev. 1 (2020). Professor Wallace and I are among the co-authors of the law school textbook *Firearms Law and the Second Amendment: Regulation, Rights, and Policy* (3d ed. 2022, Aspen Pub.). In an earlier post, we examined false claims that the AR type rifles are exceptionally powerful.

While AR rifles can be chambered in various calibers, they most commonly fire the .223 Remington and 5.56 NATO rounds. The numbers .223 and 5.56 designate the caliber of the round based on a rough approximation of bullet diameter, which is expressed in decimals an inch (.223 caliber = 223 thousandths of an inch; .45 caliber = 45 hundredths of an inch) or millimeters (5.56 caliber). The U.S. military uses the NATO designation, measured in millimeters. As detailed in our previous post, the .223 and 5.56 are mostly interchangeable.

1. **Understanding terms**

"AR" is short for "ArmaLite Rifle," inventor of the firearm in the 1950s. "AR-15" is the name for a particular model by Colt; the AR-15 is a now shrinking minority among AR type rifles, since the patents have long expired.

Like the vast majority of modern rifles, the AR fires "high velocity" bullets, whereas most modern handguns fire "low velocity" bullets. Bullet velocity is measured at various distances, since velocity declines as a bullet travels downrange. The highest velocity is the instant the bullet leaves the barrel of the gun and exits the muzzle. The velocity at that point is called "muzzle velocity."

There is no scientific or industry definition of "high velocity." American researchers who assign numerical values to the term generally use "high velocity" to refer to bullets with a muzzle velocity of at least 2,500 feet per second (fps), and "low-velocity" for bullets with a velocity of 1,200 feet per second or less.

Other things being equal, greater velocity increases a bullet's striking power. So does increasing the mass of the bullet. The overall striking power is commonly known as "kinetic energy" and is measured in foot pounds (a force of one pound

moving through a distance of one foot). The formula for kinetic energy is one-half times bullet mass times velocity squared (KE = $^1/_2mv^2$).

As we detailed in How powerful are AR rifles?, a bullet's impact on a human target is also influenced by the shape and composition of the bullet and where the bullet strikes. Our article refuted false claims from the early 1960s (which are still repeated by low-information journalists today) that the AR bullets have greater wounding effects than other rifle bullets.

In this post, we provide data about the velocity and kinetic energy of AR ammunition compared to other ammunition. We also address the false claim that AR ammunition has some supposedly unique ability to penetrate body armor or interior walls.

2. Identifying velocity and kinetic energy values for various firearms

The following chart lists the typical velocity and kinetic energy of modern handgun, rifle, and shotgun projectiles measured at the firearm's muzzle. Values in the chart are supplied from *Cartridges of the World* (17th ed. 2022) and manufacturer websites. Common AR-15 rounds (.223 and 5.56) are bolded.

For most of these calibers, *Cartridge of the World* lists ammunition from a variety of manufacturers, each with its own performance characteristics. The figures below are neither the high end nor the low end for any given caliber. For weight in grains, 7,000 grains = 1 pound. An appendix at the end of this post provides a short description of when a given cartridge type was invented, its most common uses, and the kinetic energy range of various cartridges in a given caliber.

Caliber	**Bullet Weight (grains)**	**Velocity @Muzzle ft./sec.**	**Energy @Muzzle ft. lbs.**
Handguns			
9mm Luger	115	1150	338
.357 Magnum	125	1450	583
.40 S&W	180	990	392
.44 Mag	200	1450	934
.45 ACP	230	875	391
Long-guns			
.22LR Rimfire	40	1070	102

.223 Rem	**55**	**3200**	**1330**
5.56 NATO (U.S. Army standard through 1983)	**55**	**3250**	**1325**
5.56 NATO (U.S. standard since 1984)	**62**	**3100**	**1325**
.243 Win	100	2900	1868
.260 Rem	120	3000	2395
6.5 Creedmoor	147	2695	2370
6.8 SPC	115	2608	1736
.270 Win	150	2800	2612
.30-378 Weatherby	200	3163	4440
.300 Blackout	110	2130	1107
.308 Win	165	2600	2477
.30-06	150	3000	2998
.30-30	150	2450	1995
.300 Win Mag	165	3200	3753
.338 Win Mag	250	2700	4048
.338 Lapua Mag	250	2970	4896
.416 Weatherby	300	3000	5997
.458 Win Mag	350	2500	4859
.50 BMG	750	2820	13241
12-ga shotgun slug	438	1610	2521

3. Comparing the AR's velocity and energy

The AR does *not* fire bullets four or five times faster than handguns, as claimed by President Biden and Judge Kendall. The AR bullets are about three times faster than common 9mm handguns and only a little more than twice as fast as more powerful handguns (.357 and .44 magnums).

The apples-to-apples comparison is with other centerfire rifles. All the rifle cartridges listed above are centerfire, except for the .22LR. In a centerfire cartridge, the primer is in the center of the base of the cartridge; in a rimfire, the primer is inside the rim of the cartridge base. Centerfire cartridges are generally more powerful. Rimfire cartridges above .22 caliber are not very common these days.

As the above chart indicates, ***bullet velocity among popular centerfire calibers ranges from 2450 to 3250 fps, which is 75 to 100 percent of the AR's speed.*** (The only exception is the .300 Blackout, which is effective only at short ranges).

Thus, other centerfire rifles fire bullets at speeds as fast or almost as fast as the AR-15.

The starkest difference between AR bullets and other rifle bullets is seen when comparing kinetic energy values. As with all centerfire rifle bullets, AR bullets strike with much higher kinetic energy than handgun bullets. But ***among rifle bullets, the .223 and 5.56 bullets strike with much less kinetic energy, despite their higher velocity. This is due to their smaller bullet size. For example, common hunting caliber bullets (.270, .308, .30-06) strike with around twice the energy of AR bullets.*** Larger rifle bullets (.300 Win Mag, .338 Win Mag, .338 Lapua Mag) strike with three or more times the energy of AR bullets.

A favorite tactic of "assault weapon" ban proponents is to compare AR bullet velocity to handguns to prove that the AR is far more dangerous than other semiautomatic firearms. What they don't tell you is that all centerfire rifle bullets travel at much higher speeds than handgun bullets and that AR bullets impact with much less force than most other centerfire rifles. Comparing the higher speed of AR bullets to handguns to prove ARs are exceptionally dangerous is deceptive.

The tactic is like comparing the running speed of a particular dog breed to the speed of an average housecat. Most dogs are faster than most cats. However, showing that a particular breed of dog is faster than a cat does not prove that the particular breed is much faster than other dog breeds.

4. Bullet velocity, energy, and wounding power

Higher bullet velocity does not necessarily mean greater wound severity. A ping-pong ball and a rifle bullet fired at the same velocity will produce very different terminal results. According to military trauma surgeon Dr. Martin Fackler, former director of the Army's Wound Ballistics Laboratory, and the most widely-recognized modern expert on the subject, "The false belief that a bullet damages tissue in direct proportion to its velocity is widespread." Dr. P.K. Stefanopoulos, trauma surgeon and former career military officer who has written extensively on wound ballistics, confirms that "current thinking suggests that the impact velocity can be misleading as the sole indicator of the extent and severity of the inflicted wound." ("Impact velocity" is the bullet's velocity as the moment the bullet strikes the target. Due to air friction from travel downrange, impact velocity is always lower than muzzle velocity, unless the muzzle is touching the target.)

While a bullet's speed can affect wound severity, it is not the only or even best measure. Compare the wounding effects of 00-buckshot from a 12-gauge shotgun, a .44 caliber Magnum hollow point bullet, and .22 caliber rimfire bullet—all three fired from a distance of about 15 feet. The shotgun will cause far more tissue

disruption than the .44 Magnum handgun, and the .44 Magnum handgun will cause far more disruption than the .22 rifle, despite the fact that all three have approximately the same muzzle velocity.

How bullets injure and kill has less to do with velocity and kinetic energy than with the location of impact, the bullet's physical characteristics (mass, shape, construction), and the type of tissues disrupted along the bullet's path. As we explained in an earlier post discussing the dynamics of wound ballistics, the AR certainly can cause lethal wounds, but larger caliber rifles can create more massive wounds. Especially lethal are shotguns at shorter ranges.

Wound profiles from the Army's Wound Ballistics Laboratory illustrate the permanent and temporary cavities, penetration depth, deformation, and fragmentation of both the deforming (soft point) AR .223 caliber bullet, the non-deforming 5.56mm full metal jacket (FMJ) bullet, and other larger caliber bullets typically used in hunting rifles. ***A comparison of profiles for AR bullets with the wound profiles for larger-caliber hunting and competition rifle bullets, such as the .243, .30-30, and .308, shows that the wounding effects of the larger-caliber bullets are at least as extensive as the .223 and 5.56 bullets, and typically more so.***

At shorter distances, the shotgun produces the most devastating injuries, even though the velocity of its rounds is about the same as handgun bullets. Dr. Fackler observes that at close range "the [twelve-gauge] shotgun (using either buckshot or a rifled slug) is far more likely to incapacitate than is a .223 rifle. The shotgun is simply a far more powerful weapon."

A shotgun "slug" is a single large piece of lead. Slugs are commonly used for hunting of land animals, especially in New Jersey, where rifle hunting is not allowed. The majority of shotgun users do not use slugs. Instead, their ammunition consists of a number of pellets ("shot"). For the smallest shot sizes, such as those used for dove hunting, a shot pellet might be about the size of a grain of pepper; a shot shell for doves has about 250 to 380 pellets. For larger animals, such as deer, "buckshot" is the standard. A single buckshot cartridge contains about 8 to 12 pellets, each of them with a diameter of .24 to .36 inches. (The larger the pellet, the fewer that will fit in a shotgun shell.)

In other words, a shotgun with a buckshot can instantly unleash eight or more pellets, each of them with the same diameter as a common handgun or rifle bullet. A short range, the effect is devastating, and far more so than a single bullet from a rifle or handgun. Shotgun pellets, being spheres, have lower aerodynamic stability than do conoidal rifle or handgun bullets; hence a shotgun is not effective at long ranges.

5. Penetration

Gun prohibitionists spread an additional falsehood: that the AR is more dangerous than other firearms because its high-velocity bullets pose a greater risk of penetrating body armor or of overpenetrating the interior walls of a building. For example, relying on the state's brief, Judge Andrews in *Delaware State Sportsmen's Ass'n v. Delaware Dep't of Safety and Homeland Security* stated:

> The power and velocity of assault rifle bullets pose a particularly high risk to law enforcement officers. Although the body armor typically issued to law enforcement officers protects against most handgun bullets, it is not designed to withstand the high-velocity bullets described above; assault rifles therefore "readily penetrate" such body armor.

But this is true of *all* centerfire rifles. Soft body armor worn by police only stops rounds from handguns and shotguns. Stopping rifle rounds require steel, ceramic, or composite hard plates, which are bulky and heavier. Anti-rifle plates are typically worn by soldiers or special tactics law enforcement units. Judge Andrews' point shows one way rifles can be more dangerous than handguns, but it does not explain why the AR or other "assault weapons" are themselves exceptionally lethal "far beyond" other rifles.

Federal courts also have claimed that "assault weapons" are more dangerous than other firearms because their bullets can penetrate walls and endanger people on the other side. The Fourth Circuit in *Kolbe v. Hogan* twice emphasized that the banned weapons "pose a heightened risk to civilians in that rounds from assault weapons have the ability to easily penetrate most materials used in standard home construction, car doors, and similar materials." Citing *Kolbe,* the First Circuit in *Worman v. Healey* declared that "unlike the use of handguns . . . . the use of semiautomatic assault weapons implicates the safety of the public at large. After all, such weapons can fire through walls, risking the lives of those in nearby apartments or on the street." What *Kolbe* implies, *Worman* makes explicit: "assault weapon" bullets penetrate walls, but handgun bullets do not.

That is plainly false. Nearly all handgun, rifle, and shotgun rounds will pass through walls. FBI testing indicates that to be reliably effective, bullets must penetrate soft body tissue 12-18 inches, a range necessary to reach and disrupt a vital organ in a human target. This penetration capability also means that bullets will penetrate walls if the shooter misses the target.

Contrary to *Kolbe* and *Worman,* handgun rounds will penetrate several layers of sheetrock as well as exterior house walls. The difference between handgun and rifle rounds is how they behave when passing through walls. A pistol round typically remains relatively stable, while the AR's longer and thinner .223/5.56-caliber round

is likely to fragment or to lose stability and tumble end-over-end (keyhole), losing energy rapidly due to the larger surface area hitting the drywall.

Therefore, .223/5.56 bullets generally penetrate *less* through building materials than do common handgun and shotgun rounds. This is one reason law enforcement officers often use the select-fire M4 or semiautomatic AR for raiding buildings and hostage situations, especially in urban areas.

While some bullet designs can reduce penetration through walls, the best way to minimize the chances of hurting innocent persons is to make accurate hits on the target. Because handguns require more skill to fire accurately than rifles, they typically pose a greater risk to public safety from bullet over-penetration than does the AR.

In short, the AR's high-velocity bullets have no more capability to penetrate soft body armor than do other centerfire rifles. Handgun and shotgun rounds typically penetrate building materials more than do AR rounds.

6. Summing up

Disinformation about the lethality of the civilian AR is widespread in media reports, court filings, and judicial opinions. The facts do not support claims by gun control advocates and some judges that high-velocity bullets from "assault weapons" like the AR are exceptionally dangerous or lethal. ***The AR rifle's bullet can cause more serious wounds than a handgun, but such wounds typically are no more severe than those caused by projectiles fired from shotguns or larger-caliber hunting rifles.*** The AR bullet normally penetrates less through walls than common handgun and shotgun rounds, reducing the risk to public safety from bullet over-penetration. While the AR's high-velocity bullet can penetrate soft body armor worn by law enforcement officers, almost every centerfire rifle bullet has that capability. In short, the AR's high-velocity bullet makes it a lethal weapon, but not more so than other centerfire rifles.

Appendix: Background about various cartridges

All information and quotes are from *Cartridges of the World*, 7th ed., except as noted.

Handgun

9mm Luger. Introduced 1902. Today, "the most widely used cartridge in the United States." KE range 294 to 465.

.357 Magnum. Introduced 1935 by Smith & Wesson, revolvers. At the time, the most powerful handgun load. "It is considered the best all-around handgun hunting cartridge." KE = 400 to 644.

.40 S&W. Introduced 1989. Pistol load designed for self-defense. KE = 363 to 524.

.45 ACP. Invented 1905, put to use in the venerable and still-popular Colt 1911 pistol. Widely adopted by militaries around the world. More popular for target shooting than for hunting. KE = 244 to 534.

Rifle
.22 LR (long rifle). Invented 1887. The "most popular match cartridge in existence, and also the most widely used small game and varmint cartridge." *Cartridges of the World* does not supply ballistic data for rimfire. We used the manufacturer's data for the CCI Standard Velocity 40 grain.
.223 Remington. Invented 1957, for the AR. "Practically every manufacturer of bolt-action rifles has at least one model chambered for the .223." KE = 965 to 1460.
5.56 NATO. Invented for the AR in 1960. A new version, adopted in 1984, has a 62 grain bullet instead of 55 grain; the KE at the muzzle is the same, namely 1325.
.243 Winchester. Invented 1955. Very common, "probably chambered in more different rifles than any other cartridge." Especially suited for deer. KE = 1599 to 2033.
.260 Remington. Introduced 1996. Very good for long distance target shooting. Good for hunters who want low recoil, but only powerful enough for big game with premium loads. KE = 2264 to to 2459.
6mm Creedmoor. Introduced 2007 and named for the NRA's iconic (in the 19th century) shooting range on Long Island. Popular for long distance precision shooting. KE = 3000 to 3700.
6.8 SPC (Special purpose cartridge). Introduced 2003 for US special forces, although not officially adopted. Attempts to solve the weaknesses of the 5.56mm in incapacitating an enemy. KE = 1444 to 2002.
.270 Winchester. Invented in 1925, it was the best long range American hunting cartridge to date. It is an adaptation of the standard U.S. Army rifle cartridge of the time, the .30-'06. KE = 2448 to 3045.
.30-.378 Weatherby. Invented in the 1950s under a U.S. Army contract. Used for very long range target shooting (e.g., 1,000 yards). Perhaps "the ultimate long-range hunting" cartridge for "for smaller species." KE = 4310 to 4840.
.300 Blackout. Invented 2009. Comes in both subsonic and supersonic loads, so the KE range is large: 498 to 1598.
.308 Winchester. Introduced 1951, sporterized version of the NATO 7.62x51mm. Excellent accuracy makes it popular for target shooters. Well-suited for big game smaller than moose or brown bear. KE = 2429 to 2759. (Plus subsonic variants of 480 or 538.
.30-06. Adopted 1906 as the standard U.S. Army cartridge. Derived from an 1895 Winchester cartridge. "[T]he most flexible, useful, all-around big game cartridge available to the American hunter." KE = 2033 to 3076.
.30-30 Winchester. Introduced 1895. It "has long been the standard American deer cartridge." Not appropriate for over hunting shots over 200 yards. KE = 1394 to 2045.

.300 Winchester Magnum. Introduced 1963. A "magnum" cartridge has more gunpowder than ordinary loads. For long range big game. Heavy recoil. KE = 3054 to 4187.
.338 Winchester Magnum. Introduced 1957. Designed for the heaviest big game. KE = 3518 to 4164.
.338 Lapua Magnum. Development began in 1983. For snipers and very heavy game. Shoots well even at 1500 meters. KE = 4388 to 5223.
.416 Weatherby Magnum. Introduced 1989. Made for large and dangerous game. KE = 5997 to 6477.
.458 Winchester Magnum. Introduced 1956. Made for the heaviest African game. Adapted for North American use with lighter cartridges, which account for the low end of the KE range: 2938 to 5084.
.50 BMG (Browning Machine Gun). Invented 1918 for the U.S. Army and still in use by them. Sporting use in very long distance target shooting, sometimes up to 2 miles. Not very easy to carry, as weight is 20 pounds or more. KE = 12408 to 13421.

Shotguns
Shotgun caliber is measured in "gauge." The smaller the number, the wider the gun's bore. Among the most common gauges in the U.S. today are 12, 16, 20, and 28. *Cartridges of the World* does not provide shotgun ballistics. We used the manufacturer's data for the Federal Power-Shok Rifled Slug 12 Gauge 438 Grain.

Article 2. How powerful are AR rifles? About the same as other rifles

by David Kopel & Gregory Wallace
Reason magazine, Volokh Conspiracy blog
Feb. 27, 2023

Several federal and state courts are relitigating the constitutionality of "assault weapon" bans after the Supreme Court's decision in *New York State Rifle & Pistol Association v. Bruen*. Under *Bruen*'s text-and-history test, government attorneys have argued that such laws fit within a supposed historical tradition of banning what the government calls "unusually dangerous" arms; the attorneys point to not-really-on-point historical laws about weapons such as Bowie knives or slungshots (a type of flexible hand-held impact weapon).

As detailed in a pair of previous posts, the mainstream historical tradition for controversial arms such Bowie knives and slungshots was to forbid concealed carry, to restrict sales to minors (especially without parental consent), or to impose extra punishment for misuse. But not to prohibit possession or sales for adults. *See* the previous VC posts, The legal history of bans on firearms and Bowie knives before 1900 and Bowie knife statutes 1837-1899. Although the articles are mainly about Bowie knives, many of the quoted statutes also covered slungshots.

"Assault weapons" long have been portrayed as exceptionally powerful firearms that are far more dangerous than other modern firearms and ill-suited for lawful activities like self-defense. When enacting the nation's first "assault weapon" ban in 1989, the California legislature declared that "each firearm has such a high rate of fire and capacity for firepower that its function as a legitimate sports or recreational firearm is substantially outweighed by the danger that it can be used to kill and injure human beings."

Five federal circuit courts relied on the lethality rationale pre-*Bruen* to uphold "assault weapon" bans. The First, Second, and Fourth circuits asserted that "assault weapons" have "a capability for lethality—more wounds, more serious, in more victims—far beyond that of other firearms in general, including other semiautomatic guns." The D.C. Circuit claimed that "assault weapons" like AR rifles are designed "to shoot multiple human targets very rapidly" and "fire almost as rapidly as automatics." The Seventh Circuit asserted that such firearms "enable shooters to fire bullets faster" and their "spray fire" design makes them more dangerous in mass shootings. The Fourth Circuit went so far as to hold that "assault weapons" are not protected arms under the Second Amendment because of their deadly similarity to machine guns. The First Circuit cited medical sources claiming that "assault weapons" cause far more devastating wounds that other firearms and declared that using such firearms for home defense "is tantamount to using a sledgehammer to crack open the shell of a peanut."

Thus, the prohibition argument is based on 1. Rate of fire, and 2. The power of the weapons' bullets.

The rate of fire claim is preposterous. ***Semiautomatic rifles as a class (including those that are supposedly "assault weapons") fire at essentially the same rate as semiautomatic handguns.*** These handguns, from companies such as Ruger, Smith & Wesson, Springfield, or Glock, are the most common defensive firearms in the United States; under the Supreme Court's decision in *District of Columbia v. Heller*, they may not be prohibited. As then-Judge Kavanaugh argued in his dissent in *Heller II,* it is irrational to single out semiautomatic rifles for prohibition based on rate of fire, given that semiautomatic handguns are plainly constitutionally protected. *Heller v. District of Columbia*, 670 F.3d 1244 (D.C. Cir. 2011) (Kavanaugh, J., dissenting).

This post will mainly discuss the second argument: that "assault weapon" bullets are much more destructive than bullets from other firearms. This post is co-authored by Campbell University law professor Gregory Wallace, who has published two articles on "assault weapons," the most recent being *"Assault Weapon" Lethality*, 88 Tenn. L. Rev. 1 (2020). Professor Wallace and I are among the co-authors of the law school textbook *Firearms Law and the Second Amendment: Regulation, Rights, and Policy* (3d ed. 2022, Aspen Pub.)

As post-*Bruen* litigation proceeds, more absurd claims are appearing in court filings and opinions about the extreme firepower of "assault weapons" and their unsuitability for self-defense. This post discusses two such examples. The first is from the California Attorney General in *Rupp v. Bonta*, a case challenging California's "assault weapon" ban. It was remanded by the Ninth Circuit for reconsideration in light of *Bruen* and is currently pending in federal district court in California. The second is from a recent federal district court opinion in *Bevis v. City of Naperville, Illinois,* denying a preliminary injunction against state and local "assault weapon" bans.

The discussion below involves precise description of the wounding effects of different types of ammunition. If you don't want to read such things, that is your reasonable choice. Just don't make decisions about what arms persons under your direct or indirect control can possess if those decisions are based on wounding effects and you refuse to be informed about wounding effects.

I. The names of different rifles

Let's start with some nomenclature for firearms models. The "AR" in AR-15 stands for "ArmaLite Rifle." It was the 15th model invented by the ArmaLite company. The AR-17 (which never went very far) was a shotgun. The AR-15 was an improved version of the AR-10 of 1956. In 1959, ArmaLite sold the AR-15 patents to Colt's Manufacturing Company.

Colt's then produced two firearms lines from the patents. The semiautomatic AR-15 rifle was introduced to the civilian market in 1964. The M16 was an automatic (machine gun) version for military use; it was sold in large quantities to the U.S. military and became a standard infantry weapon during the Vietnam War. The M16 and AR-15 look the same, except that the M16 has a selector switch that allows the user to choose automatic fire. Internally, the M16 has components for automatic fire and the AR-15 does not. Today, the military has adopted an improved version of the M16, namely the M4 carbine. (A carbine is a relatively short rifle.)

Meanwhile, the patents that Colt's had bought from ArmaLite expired in 1977. Today, most rifle manufacturers make a rifle based on the AR platform. However, Colt's still owns the tradename "AR-15." So precisely speaking, none of the firearms from the other manufacturers can be called an "AR-15." This post, except when quoting or summarizing writings that incorrectly use "AR-15" when they mean a broader group of rifles, will simply use the term "AR" for the class of rifles that use the AR platform.

II. Colonel Tucker's expert declaration in *Rupp*

The California AG has served the *Rupp* plaintiffs with an expert report and declaration from retired Colonel Craig Tucker, U.S. Marine Corps, who served as an

infantry officer for 25 years and commanded combat units in Iraq. The curriculum vitae attached to his report is impressive and his service appreciated. Colonel (Ret.) Tucker did not disclose in either his report or CV that he is a founding member of the Veterans Advisory Council to Michael Bloomberg's gun-control advocacy group Everytown for Gun Safety.

Describing the purported lethality of the civilian AR-15, the most popular target of "assault weapon" bans, the Tucker report states:

> The AR-15 and M4 are both designed to fire a .223 round that tumbles upon hitting flesh and rips thru the human body. A single round is capable of severing the upper body from the lower body, or decapitation. The round is designed to kill, not wound, and both the AR-15 and M4 contain barrel rifling to make the round tumble upon impact and cause more severe injury. The combination of automatic rifle and .223 round is a very efficient killing system. The same can be said of the AR-15.

These five sentences are a cascade of errors and absurdities.

II.A. *"The AR-15 and M4 are both designed to fire a .223 round . . ."*

The Tucker declaration asserts that the M4 is "designed to fire a .223 round." In fact, the military's M4 carbine is designed to fire the 5.56mm NATO round, not the civilian .223 Remington round. It is difficult to understand how a Marine colonel with combat infantry experience would think the M4 is designed for the .223 round.

The numbers .223 and 5.56 designate the caliber of the round based on a rough approximation of bullet diameter, which is expressed in thousandths of an inch (.223 caliber) or millimeters (5.56 caliber). The U.S. military uses the NATO designation, measured in millimeters.

While the .223 and 5.56 rounds have the same bullet diameter, there is a difference. The case for the 5.56mm has a .125-inch longer throat and thus can be loaded with additional gun powder, resulting in slightly higher performance. The military M16 and M4 are 5.56mm. Civilian guns on the AR platform are sometimes .223, but the majority are 5.56mm (still able to use .223), or other calibers. Because of the higher pressure created when fired, the 5.56 round should *not* be used in an AR rifle chambered only for the .223 round. The .223 round *can* be used in a 5.56 chamber, but may cause improper cycling (*e.g.*, jams) with shorter barrels.

II.B. *"that tumbles upon hitting flesh and rips thru the human body."*

To understand why this statement is false requires an explanation of wound ballistics, the study of the effects of a penetrating projectile on living tissue. Dr. Martin Fackler, military trauma surgeon, former director of the Army's Wound

Ballistics Laboratory, and the most widely-recognized modern expert on the subject, observed that "[p]robably no scientific field contains more misinformation than wound ballistics."

> A firearm bullet is propelled by the expanding gas from a gunpowder explosion. Other things being equal, a bullet fired from a longer barrel will have higher velocity than a bullet fired from a shorter barrel. For example, a bullet that travels through a 16 inch rifle barrel will spend about four times longer being propelled by the expanding gas than will a bullet that travels through a 4 inch handgun barrel.

Bullets from AR rifles, like bullets from most other modern rifles, typically have about three times the muzzle velocity of common handgun bullets. Muzzle velocity is measured at the moment the barrel exits the bullet; as the bullet travels downrange, velocity declines due to air friction.

More velocity does not necessarily mean greater wound severity—a ping-pong ball and a bullet fired at the same muzzle velocity will produce very different effects on the target (*terminal results*).

A starting point in wound ballistics is the kinetic energy of the bullet when it strikes the target. The formula is: KE = 1/2 x mass x (square of the velocity). Other things being equal, a bullet that is twice as heavy as a different bullet will have twice the kinetic energy.

Both velocity and bullet mass contribute to kinetic energy. Rifle bullets in general strike with much higher kinetic energy than do handgun bullets, because the rifle bullets have higher velocity.

But the bullets for the most common AR calibers (.223, followed by 5.56mm) are much smaller than the bullets from many other rifles. Thus, they strike with only about a half to a third of the kinetic energy of larger caliber rifle bullets, such as .270, .30-'06, .308, .338, .444, and so on. The larger bullets not only have a greater width (*i.e.* caliber), they also typically are longer.

If we were in the year 1700, then the wound ballistics analysis would be at an end, since at the time all bullets had the same shape. They were spheres. That is why today a unit of ammunition is still called a "round." However, since the early 1800s, conoidal bullets have been the norm. The shape improves aerodynamic stability, so the bullet can travel further and with less loss of velocity.

Then as now, the location of impact and type of type of tissues disrupted along the bullet's path is more influential than kinetic energy, velocity, or mass. Today, the bullet's shape and construction materials are also very important.

Tissue damage from bullets comes primarily from the permanent *crushing* of tissue in the bullet's path. This is the *permanent cavity* (a/k/a *permanent track*).

Additionally, if the bullet is traveling fast enough, the pressure wave following the bullet can cause temporary *stretching* of tissue surrounding the bullet's path. This is the *temporary cavity* (a/k/a *temporary track*).

The size of the permanent cavity is proportional to the size of the bullet. The size of the temporary cavity can vary greatly, depending on the size and location of the temporary cavity on the bullet's path and the elasticity of the tissue affected.

More elastic tissue can absorb energy more easily, and is therefore much more resistant to injury from temporary cavitation. Such tissue includes muscle, lungs, skin, blood vessels and empty or hollow organs such as the stomach, bladder, or intestines.

Less elastic tissue, such as the brain, liver, kidney, and fluid-filled organs (*e.g.*, the heart), are more likely to shatter, rupture, or tear due to temporary cavitation. Bone fractures from temporary cavitation are rare—when a bone is shattered, it usually is due to being struck by the bullet. Injuries to extremities normally come from being hit by the bullet or bullet fragments (or bone fragments if the bone is hit) rather than by temporary cavitation.

Notwithstanding Col. Tucker's claim, the bullets fired from an AR do not "tumble[] upon hitting flesh."

Bullets never "tumble" in the ordinary sense of the word. That is, they do not perform repeated 360 degree rotations horizontally or vertically. In human tissue, an intact bullet can change the angle of penetration by up to 180 degrees, meaning that the back of the bullet is now the front. The most damage occurs when the bullet has rotated 90 degrees. Then, the entire length of the intact, nondeformed bullet disrupts tissue, thus creating a larger permanent wound cavity and a larger temporary cavity.

Changes in bullet angle are called *yaw*. While some ballistics experts distinguish horizontal changes (yaw) from vertical changes (pitch), most use "yaw" for any change in angle.

Below, we will describe how some military ammunition, with which Col. Tucker is presumably familiar, can yaw—that is, change angle by as much as 90 to 180 degrees in human tissue. What Col. Tucker does not understand is that many civilian AR users do not choose the yaw-prone 5.56mm full metal jacket ammunition that the U.S. military uses. In fact, many AR users choose ammunition that is designed *not* to yaw but instead to deform.

A bullet can yaw if it stays physically intact, retaining its shape as it moves though the target. But many bullets, especially those made for self-defense, are designed *not* to stay intact. These bullets are designed to fragment, expand, or deform when they strike a target. For simplicity, we will call such bullets "deforming bullets," because they are designed to lose their original form when they strike.

Why is deforming ammunition often chosen for defensive rifles and handguns of all types? Why do many law enforcement agencies mandate that their deputies and officers use such ammunition? The main reason is safety.

If a bullet stays intact, there can be two results: It can just come to a stop in the body. Or it can continue through the body and exit the other side, creating an *exit wound* (as opposed to an *entry wound*).

This can be a bad result for two reasons: First, the exited bullet could hit another person. For example, when Alec Baldwin shot a victim on a movie set, the bullet entered her chest, killed her, exited, and then struck and injured a second victim. In a law enforcement or self-defense situation, the bullet that exited the criminal's body might hit an innocent victim.

Second, the purpose of shooting another person is to make that person stop doing something immediately, such as perpetrating a violent felony. Therefore, all of the kinetic energy from the bullet should be delivered to the perpetrator, to increase the possibility that the bullet will stop the perpetrator.

Deforming bullets are designed to not exit the body. Instead, they are designed to impart all their kinetic energy to a single target. Because they are made not to stay intact, they do not yaw, or to use Col. Tucker's word, "tumble."

There are many varieties of deforming ammunition, based on shape, materials, and construction. For example, in a hollow-point bullet, the tip opens up like flower petals as its moves through the target. Similarly, a solid soft tip on a bullet might flatten or "mushroom." The expansion by whatever means gives the bullet a larger diameter, which crushes more tissue; it also increases the size of both the permanent and temporary cavities. When the bullet deforms or expands, it becomes blunter and thus more stable, preventing the "tumbling" described by Col. Tucker.

Such bullets also can fragment in tissue, with the fragments spreading out and creating their own permanent wound tracks separate from the main wound track. These fragments greatly increase the permanent cavity size as they tear and detach tissue displaced by the temporary cavity. A deforming or fragmenting bullet from a powerful handgun can produce similar effects to tissue, resembling those from a much faster rifle bullet.

Thus, in most situations of lawful defense of self or others, deforming/expanding bullets do the best job of increasing the likelihood that the imminent or ongoing attack will be stopped, *and* of reducing the risk that an exited bullet could injure a bystander.

Most rules have exceptions. One of the situations when deforming/expanding bullets might not a preferred choice for self-defense is in bear country. Some people say that a flat-nosed, non-deforming bullet is the one with the best chance of making its way through an attacking bear's massive rib cage.

Col. Tucker's declaration provides no indication that he has any familiarity with the above: namely that civilian ***AR users can and often do choose AR ammunition that is specifically designed* not *to tumble.***

Instead, Col. Tucker seems to mistakenly believe that all civilians users of AR rifles use the same ammunition as does the military for the M16 and M4. That ammunition is 5.56mm FMJ (full metal jacket). In a full metal jacket, the lead bullet core is surrounded by a jacket of metal. Lead is a very soft material. On the Moh's Hardness scale of 1-10, lead is 1.5—below a fingernail (2.5), penny (3.5), or diamond (10).

With unjacketed bullets, there is substantial lead abrasion due to friction as the bullet travels down the barrel. *Lead fouling* degrades accuracy. In combat situations, when a soldier might have to fire hundreds or thousands of rounds with no opportunity to clean the gun, preventing lead fouling is important. Because the full metal jacket is made of harder material than lead, much less lead abrasion builds up in the gun barrel. This is one of the reasons why full metal jacket is preferred in a military context.

For bullets that do not deform, tissue damage is (relatively) minimal as long is the bullet travels point-forward. But, as described above, some rifle bullets, such as the military 5.56 round with a full metal jacket, can yaw as much as 180 degrees, increasing wound severity. In contrast, most nondeforming handgun bullets yaw at least a little, but usually not enough to cause significant additional damage.

Nondeforming bullets from any firearm also may fragment due to stress from yawing against gravity, or after striking bone. Fragmentation increases wound severity, as described above.

In short, a nondeforming round, such as the military 5.56mm with a full metal jacket, might travel intact more or less intact through a target and could hit someone else. Or it might fragment or significantly yaw, causing greater damage.

According to the California Attorney General and Col. Tucker, the .223 round begins to instantly tumble "upon hitting flesh." ***As explained above, many civilian .223 or 5.56mm rounds are designed* not *to "tumble."***

Suppose we revise Col. Tucker's declaration so that it applies only to the 5.56mm FMJ rounds with which he is familiar, and not to the plentitude of AR rounds of which he apparently has no knowledge. With a corrective and vastly narrowing construction, is Col Tucker accurate? That is, is it true that the 5.56 FMJ "tumbles upon hitting flesh"? Certainly not.

Dr. Fackler found that about 85% of military 5.56mm FMJ bullets travel point-forward at least five inches before beginning to yaw. The straighter the bullet hits the target, the longer it will take to yaw after it strikes. Thus, a nondeforming full metal jacket rifle bullet can pass completely through a human target without yawing or fragmenting, leaving a small wound channel and relatively mild injury unless it strikes a vital organ, bone, or other critical structure.

The M16 and M4 have always been subjects of military controversy. On the one hand, they are much more accurate, when functioning, than their Soviet counterpart rifles, such as the AK-47 and its lineage. The AK-47 is the automatic (*avtomat* in Russian) rifle invented by Mikael Kalashnikov and first manufactured in 1947. Like the M16 and M4, and unlike ARs, the AK-47 is capable of automatic fire. Compared to the AK-47, American guns are more fragile in adverse conditions, such as sand storms. The Soviet guns were built to looser tolerances (how closely the parts fit together). The result is that American rifles are more accurate when clean and Soviet rifles are less affected by dust and grit.

The modern American infantry weapons have also been controversial for another reason. Compared to the rifle ammunition issued to almost all armies past and present, the 5.56mm FMJ is unusually lightweight. This is an advantage because a soldier can carry more ammunition, and thus continue fighting longer even when resupply is not available. This is same reason that in the 18th century, American long hunters, who might be out on expeditions for months, down-graded their calibers from the standard musket calibers of .60 or .75 to the .46 or .32 of the Pennsylvania/Kentucky rifles. The less the ammunition weighs, the more one can carry.

The disadvantage is the lower the ammunition weight, the less the stopping power. As explained above, any reduction in bullet weight is exactly matched by a reduction in kinetic energy.

There have been numerous reports that the military's 5.56 FMJ round has insufficient terminal effectiveness in combat. Combat veteran and military small arms expert Jim Schatz explains, "The disturbing failure of the 5.56x45mm caliber to consistently offer adequate incapacitation has been known for nearly 20 years."

He describes one Special Forces (SF) mission in Afghanistan when an insurgent was shot seven or eight times in the torso with the 5.56 round, got back up, climbed over a wall, and reengaged other SF soldiers, killing a SF medic. The insurgent then was shot another six-to-eight times from about 20-30 yards before finally being killed by a SF soldier with a handgun.

Similarly, Rob Maylor, a former Australian SAS sniper, has "on several occasions witnessed bad guys being hit multiple times by 5.56mm . . . at varying ranges and then continue[] to fight." He explains that while the 5.56 round is designed to yaw and fragment, "[t]his isn't happening all the time and as a result projectiles are passing through the body with minimal damage."

Mark Bowden's bestselling book *Black Hawk Down* gives vivid accounts of less-than-lethal performance of the Army's green-tip 5.56mm bullet (M855) in the Battle of Mogadishu in 1993. He describes one Delta operator's rounds as

> passing right through his targets. When the Sammies were close enough he could see when he hit them. . . . [I]t was like sticking somebody with an ice pick. The bullet made a small, clean hole, and unless hit happened to hit the heart or spine, it wasn't enough to stop a man in his tracks. [The operator] felt like he had to hit a guy five or six times just to get his attention.

These instances are consistent with Dr. Fackler's own findings. He recounts that

> [i]n 1980, I treated a soldier shot accidentally with an M16 M193 bullet from a distance of about ten feet. The bullet entered his left thigh and traveled obliquely upward. It exited after passing through about 11 inches of muscle. The man walked into my clinic with no limp whatsoever: the entrance and exit holes were about 4mm across, and punctate. X-ray films showed intact bones, no bullet fragments, and no evidence of significant tissue disruption caused by the bullet's temporary cavity. The bullet path passed well lateral to the femoral vessels. He was back on duty in a few days. Devastating? Hardly.

Dr. Fackler further notes that "[i]n my experience and research, at least as many M16 users in Vietnam concluded that [the 5.56mm] produced unacceptably minimal, rather than 'massive,' wounds."

Like any firearm, the AR rifle in typical calibers such as .223/5.56mm, can cause serious or lethal wounds, and so can other rifles, shotguns, and handguns. Wound profiles from the Army's Wound Ballistics Laboratory illustrate the permanent and temporary cavities, penetration depth, deformation, and fragmentation of both the deforming (soft-point) .223 caliber bullet, the non-deforming 5.56mm FMJ bullet, and other larger caliber bullets typically used in hunting rifles (e.g., .30-30, .308). A comparison of those profiles shows that the ***wounding effects of the larger***

caliber bullets are at least as extensive as the .223/5.56, and typically more so.

According to Dr. Fackler, the .223 Remington is "a 'varmint' cartridge, used effectively for shooting woodchucks, crows, and coyotes." Because of its smaller size, there is an ongoing debate among hunters over whether the .223 round has adequate terminal performance for taking deer or larger game. Some states ban the use of .223 caliber rifles when hunting deer and other animals larger than varmints because their rounds lack sufficient power. The ethos of hunting is to take an animal with a single fatal shot. In the views of some state game commissions, the usual AR calibers of .223 and 5.56mm are too weak; at least a .270 is required for hunting deer, antelope, or anything larger.

II.C. "*A single round is capable of severing the upper body from the lower body, or decapitation."*

This is the most implausible claim in Col. Tucker's report, which is made under oath and theoretical penalty of perjury. He declares that his report "is based on my own personal knowledge and experience, and, if I am called as a witness, I could and would testify competently to the truth of the matters discussed in this Report."

No one disputes that wounds from an AR rifle, like any firearm, can be fatal. That such wounds can be "capable of severing the upper body from the lower body, or decapitation" is false.

Buford Boone is the former director of the FBI's Ballistic Research Facility for 15 years and one of the world's leading authorities on internal, external, and terminal ballistics. In his expert witness rebuttal report in *Rupp v. Bonta,* he describes this claim as "so ridiculous that it should, and actually does, cast doubt on [Col. Tucker's] qualifications as an expert in the field of firearms, particularly as it relates to wound ballistics."

Col. Tucker offers no examples or authority to support his claim. No doubt he will be asked at deposition or trial whether he has personally witnessed a person being decapitated or having his upper body severed from his lower body by a single .223 or 5.56 round. Mr. Boone explains in his rebuttal report why it is unlikely Colonel Tucker can answer truthfully in the affirmative:

> In almost 26 years of professional involvement in the field of wound ballistics, I have never heard, even anecdotally, of an incident wherein a person was decapitated or their upper body was severed from their lower body as a result of being shot by a single projectile fired from any small arm. ["Small arm" is a term of art to distinguish hand-carried weapons from larger arms, such as naval artillery.] It is notable that the .223/5.56 is on the lower end of terminal performance potential of the vast calibers available in centerfire rifles. In

> fact, the .223/5.56 is below the allowable minimum cartridges for deer hunting in some states. Additionally, since reading Colonel (Ret.) Tucker's supplemental report, I have shared that statement with many associates in the firearms field. All have questioned the credentials of an "expert" that would make such a claim. It is my opinion that no examples have been provided because such performance has never been witnessed.

Although perhaps never "witnessed," claims that "assault weapons" can decapitate or dismember have appeared in several media reports and at least one court opinion. They can be traced to a U.S. military report from Vietnam in 1962. Derivatively, an NPR report on the Uvalde murders in May 2022 describes the civilian AR as "designed to blow targets apart" and claims that "its bullets travel with such fierce velocity that they can decapitate a person." The NPR article links to an article in *The Intercept* that cites a military report describing how "Viet Cong fighters hit with the weapon were frequently decapitated and dismembered, many looking as though they had 'exploded.'" *The Intercept* article links to a *Gawker* story that quotes extensively from the military report about "how the AR-15, chambered with the same .223 ammunition that it uses today, not only killed VC soldiers but decapitated and dismembered them." In *Kolbe v. Hogan*, the Fourth Circuit cited the same military report to prove the extreme lethality of the civilian AR. Military testing, the court said, found that high-velocity projectiles from the AR caused "[a]mputations of limbs, massive body wounds, and decapitations."

However, as detailed above, the US military in Vietnam never used civilian ARs or .223 ammunition; the military used M16 rifles with 5.56mm ammunition.

The testing of the M16 with 5.56mm cited by the Fourth Circuit and some credulous media was conducted as part of Project AGILE, part of a research program in Southeast Asia initiated by the Department of Defense's Advanced Research Projects Administration (DARPA). At the time, the military was considering whether to replace the M14 (a Korean War gun) with the M16 as its primary combat rifle. Project AGILE supplied M16 rifles to South Vietnamese combat troops for field trials to determine whether the M16 would perform satisfactorily in combat. The subsequent report included claims of massive injuries from the M16's 5.56mm round, including two amputations and a decapitation.

These claims were never confirmed. The Army's Wound Ballistic Laboratory at Edgewood Arsenal tested the lethality of the M16 in gelatin, animals, and cadavers but could not duplicate the "theatrically grotesque wounds" reported by Project AGILE. C.J. Chivers, a Pulitzer Prize winning *New York Times* journalist, extensively researched the testing for his book *The Gun*. "No matter what they did," writes Chivers, "they were unable to reproduce the effects that the participants in Project AGILE claimed to have seen." As Chivers writes:

> even the hollow-points [common for civilian use, but not military] failed to duplicate anything like the spectacular effects recorded by the Vietnamese unit commanders and their American advisors, which had subsequently been taken as fact and much used in the . . . campaign to sell the AR-15. [Recall that the "AR-15" was at first a marketing term for both the automatic M16 and for non-automatic rifles.]

The Wound Ballistic Laboratory's lethality study was kept secret for more than four decades, Chivers explains, with the result that "at the most important time, during the early and mid-1960s, the Project AGILE report, with its suspicious observations and false conclusions, remained uncontested." The M16 "continued to rise, boosted by a reputation for lethality and reliability that it did not deserve."

In other words, the military wanted to switch to the M16, notwithstanding complaints from many soldiers that it is underpowered. The military used the sensational Project Agile claims, including two purported instances of limb amputations and one of a decapitation, to counter the complaints about the M16's weak firepower. The military in fact knew that the claims from Project AGILE could not be true, because extensive testing by the Army's Wound Ballistic Laboratory had proven that the Project AGILE claims were not true. Nevertheless, the military insisted on adopting the M16 and suppressed the true facts reported by the Wound Ballistic Laboratory.

Dr. Fackler recounts that there were other claims in the 1960s and 70s that the M16's high velocity bullets caused "massive" and "devastating" injuries, but these claims were disproven or contradicted by other reports. Delegates to war surgery conferences in the early 1970s "reported no unusual problems associated with 'high-velocity' bullet wounds in Vietnam. There were no reports of rifle bullet wounds causing traumatic amputations of an extremity."

Combat veterans have rejected claims that .223 or 5.56 rounds are capable of beheading people. Delta operator Bob Keller said he has never seen anyone decapitated by an AR round and called the claim "bullshit." Rob O'Neill, the Navy SEAL who killed Osama bin Laden, said the claim is "100% inaccurate" and "there is no way, no way" that a .223 or 5.56 round can decapitate someone. "As a former Navy SEAL who has shot people up close with something similar to an AR-15, you don't blow their head off, it's not how it works." O'Neill added, "I shot bin Laden three times in the head up close with the same caliber and it didn't decapitate him."

In sum, Col Tucker's "expert" claim that a .223 round can cut a body in half is incorrect.

II.D. ***"The round is designed to kill, not wound . . ."***

Every ordinary round—whether fired from a handgun, rifle, or shotgun—fairly can be described as "designed to kill." Some specialized rounds are marketed as "less than lethal"—*e.g.*, rubber bullets, beanbag rounds; they typically injure and sometimes kill. No normal lead ammunition is specifically "designed to wound" and not kill. All defensive ammunition is designed to take the adversary out of the fight, and for no other purpose. The purpose can be accomplished either by killing or with a wound severe enough to incapacitate the adversary.

II.E. ***"and both the AR-15 and M4 contain barrel rifling to make the round tumble upon impact and cause more severe injury."***

Here, Col. Tucker's claims become bizarre. Rifling is spiral grooves or other features on the inside surface (bore) of the barrel that spin the bullet on its longitudinal axis as it travels down the barrel. Within the bore, the raised parts are the *lands* and the flat parts are the *grooves*. By definition, every rifle contains rifling. So do almost all handguns. Rifling makes the bullet spin on its long axis, and improves aerodynamic stability. Rifling is not a feature unique to the AR; every rifle has rifling.

The purpose of rifling is to stabilize the bullet in flight, not to make the bullet tumble when it strikes. Tumbling (rotating end over end) is the opposite of stability. The higher the barrel's "twist" rate—how many inches a bullet must travel down the barrel to rotate one full turn—the more aerodynamically stable the bullet will be. Think of a football: the tighter the spiral, the faster, farther, and more accurately it will travel.

What of the M16? Very early select fire models of the AR-15 (before it became the M16) had a slow twist rate of 1:14; that is, in a 14 inch barrel, a bullet would rotate once. In a longer barrel, such as 24 inches, the bullet would still rotate less than twice. Due to Swedish objections about the slow twist rate, the first M16s put into service has a twist of 1:12. A misconception arose bullets with the 1:12 twist would yaw or tumble in flight. Dr. Fackler explains:

The notion that a common cause of increased wounding is the bullet's striking at large yaw angles (angle between the bullet's long axis and line of flight), or even sideways due to "tumbling" in flight is clearly fallacious. Anyone who has ever shot a rifle and observed the holes made by the bullet recognizes that they are round, not oblong, as would be the case if they yawed or tumbled in flight. This misconception seems attributable in large measure to misinterpretation of a report published, in 1967, by Hopkinson and Marshall. These authors presented diagrams of the yaw angles and patterns made by the bullet tip in flight. The angles on their drawings were exaggerated for clarity, showing 25 to 30 degrees rather than the 1 to 3 degrees that actually occur for properly designed bullets of small arms. . . . Thus

bullet yaw in tissue, an important consideration, has been confused with bullet yaw in flight, which is, in most cases, of negligible consequence.

Dr. Fackler was describing what every target shooter knows from observation. Whether shooting near or far, and no matter what the gun, the holes in paper targets will be circles. Perhaps imperfect circles, with one side three degrees greater than the other. At whatever distance, a bullet through air only slightly deviates from a perfectly straight path, accounting for wind effects and gravity over distance.

During the 1960s, the fairly low twist rate of 1:12 did often result in yawing and fragmentation upon impact. These days, the military M4 has been improved with a 1:7 twist. (So in a 21 inch barrel, the bullet would rotate on its long axis three times before exiting the muzzle.) Civilian ARs today typically have twist of 1:7 to 1:9. Overall, there is no significant bullet yaw or pitch during flight, regardless of gun. If any occurs after penetration, that is due to the matter encountered, rather than the rifling of the gun.

Finally, Col. Tucker claims that the rifles he is denouncing (AR-15, M4) are designed for offensive combat, not self-defense:

> I carried my M4 for offensive combat and a handgun for self-defense. Defensive combat is generally up close and very personal. At that range, it is very difficult to use a rifle as a defensive weapon, except as a blunt force instrument.

This will come as great surprise to the many millions of Americans who have relied on a rifle as their primary home defense arm. Granted, rifles are less maneuverable than handguns at very close quarters; even so, rifles are more accurate because they are easier to aim, more stable when held, and have longer barrels. The AR in particular has low recoil, making it easier for users with limited upper body strength to control. As explained in a pro/con article by Guncraft Training Academy, one of the advantages of an AR rifle compared to a handgun is that the AR bullet is much smaller than typical defensive handgun rounds. Hence, the bullet loses velocity sooner than does a bigger bullet when it strikes the target. Therefore, the AR bullet is less likely to *over-penetrate*—that is, to exit the criminal's body and thereby endanger other people.

III. The *Bevis v. City of Naperville* opinion

The federal district court opinion in *Bevis v. Naperville* offers a preview of how *Bruen*-defying lower courts will uphold "assault weapon" bans. The *Bevis* Judge, Virginia M. Kendall, had previously held that Chicago's ban on all public firing ranges in the city did not violate the Second Amendment. *Ezell v. City of Chicago*, 2010 WL 3998104 (N.D. Ill., Oct. 12, 2010). That decision was later reversed by the Seventh Circuit. 651 F.3d 684 (7th Cir. 2011).

In *Bevis*, Judge Kendall declared that "[a]ssault weapons pose an exceptional danger, more so than standard self-defense weapons such as handguns." She cited in support the Second Circuit's pre-*Bruen* assertion in *New York State Rifle & Pistol Ass'n v. Cuomo* that "these weapons tend to result in more numerous wounds, more serious wounds, and more victims." These claims are incorrect.

III.A. Rate of fire: "more numerous wounds . . . more victims"

Like the pre-*Bruen* circuit courts, the Judge Kendall first addressed the banned firearms' rate of fire; they "fire quickly," she said. Civilian semiautomatic-only "assault weapons" are not machine guns; they fire only one round for each pull of the trigger. While Judge Kendall initially claimed that an "assault weapon" can empty a 30-round magazine in six seconds, she conceded that a more realistic rate of fire is one round per second. At that rate, however, "assault weapons" are no more dangerous than handguns, from which an average shooter typically can fire two or three rounds a second.

III.B. Terminal effects: "more serious wounds"

Judge Kendall then described the supposedly massive wounds that "assault weapons" produce when their bullets strike, something also emphasized in the pre-*Bruen* circuit court decisions. She briefly addressed two factors—muzzle velocity and bullet penetration—to show that "assault weapons" produce more devastating wounds than other firearms. Their bullets "hit fast and penetrate deep into the body," she said.

III.B.1. Muzzle velocity

To support the first factor, the Judge Kendall claimed the muzzle velocity of an "assault weapon" is "four-times higher than a high-powered semiautomatic firearm." That claim is untrue, unsupported by the cited authority, and nonsensical. Of course rifles in general have higher velocity than handguns in general, because rifles definitionally have much longer barrels. Most handgun barrels are six inches or less; rifle barrels are, by federal law, at least 16 inches. (Rifles with shorter barrels require special registration and taxation by the Bureau of Alcohol, Tobacco, Firearms, and Explosives, pursuant to the National Firearms Act of 1934).

To say that a given rifle has greater velocity than handguns is true, but this is not in any way unique to AR rifles.

The muzzle velocity of a 55-grain .223/5.56 round from an AR is around 3200 feet-per-second (fps), while larger-caliber rounds used in hunting and other types of rifles have muzzle velocities from 2500-3000 fps. Popular 9mm, .40, and .45 caliber handgun rounds typically have muzzle velocities from 1000-1200 fps. So do most 40-grain .22 caliber rimfire long rifle (LR) rounds. (The puny .22LR is popular for both

rifles and handguns; its low power makes it an excellent choice as a child's first firearm.)

At most, the muzzle velocity of an "assault weapon" is three times that of lower-velocity semiautomatic handgun round.

Judge Kendall cited an article by Dr. Peter Rhee et al. to support the "four-times higher" claim. Muzzle velocities of various firearms do not appear on the cited page (855), but do in two charts on the next page (856). Nothing in the charts or the text states or supports the "four-times higher" claim; in fact, the muzzle velocities in the article reflect those set out above. It is unclear where the judge came up with the "four-times higher" figure.

Not only is Judge Kendall's claim wrong and unsupported, it is nonsensical. She declares that the banned weapons fire four-times faster than a "high-powered semiautomatic firearm." Ban advocates and the media often refer to semiautomatic "assault weapons" as "high-powered." In target rifle competitions, all calibers above the diminutive .22 are called "high power." So competitors using a .22 rifle would compete in one class, and competitors with larger rifles would compete in a different class.

The Rhee article defines "high-velocity" bullets as those with a velocity of at least 2500 fps, while "low-velocity" bullets travel at 1200 fps or less. If an "assault weapon" and a "high-powered semiautomatic firearm" are one in the same, any comparison between the two is nonsensical.

Judge Kendall's reliance on bullet velocity to prove "assault weapons" are exceptionally dangerous misunderstands the fundamentals of wound ballistics. Her claim is really just an observation that rifles in general are more powerful than handguns in general.

II.B.2. Wound damage

While "assault weapon" bullets typically "penetrate deep into the body," Judge Kendall accurately noted, so do handgun bullets. FBI testing shows that to be reliably effective, handgun bullets must penetrate soft body tissue 12-to-18 inches, a range necessary to reach and disrupt a vital organ in a human target.

Judge Kendall offered a description of the wounding effects of "assault weapon" bullets to depict them as highly dangerous. Rather than citing scholarly articles on wound ballistics or quoting wound ballistics experts or military trauma surgeons who regularly treat rifle wounds, she relied on an NPR report and an opinion article in *The Atlantic*.

The NPR report was published following the Uvalde, Texas, murders. Judge Kendall quoted one doctor from the article who describes bullets from "assault weapons" as causing "cavitation" in which the projectile creates a "large cavity." But both handgun and rifle rounds can cause large temporary cavities. Dr. Fackler notes that "[t]emporary cavitation is not a modern phenomenon associated exclusively with projectiles of high velocity." He describes the temporary cavitation caused by common handgun rounds. All centerfire rifle bullets (that is, every modern round bigger than the .22 rimfire) and large handgun bullets often cause a large temporary cavity. The size of the cavity can vary considerably, depending on the tissue in which it forms. The *NPR* doctor's quote describes a common characteristic of handgun and rifle wounds; it does not describe anything exceptional about "assault weapons."

Judge Kendall also quoted an op-ed in *The Atlantic* by a radiologist who viewed AR wounds from the Parkland shooting from her computer screen. Supposedly, the bullet "does not actually have to hit an artery to damage it and cause catastrophic bleeding."

While it is not impossible for the temporary cavity to tear a hole in an artery, it is rare. Dr. Fackler explains that "[b]lood vessels are usually simply pushed aside and are almost never disrupted by temporary cavitation." He observed one case in which the temporary cavity created by an expanding *handgun* bullet tore a hole in the aorta at its junction with the right renal artery. He writes, "*I must emphasize the extreme rarity of this case.* I never published it, however, not wishing to add to the widespread wildly exaggerated effects attributed to the temporary cavity by many" (original emphasis).

The Atlantic writer further claimed that "[e]xit wounds can be the size of an orange."

Assertions that .223/5.56 rounds create huge exit wounds often appear in media accounts. One radiologist calling for "common sense gun reform" claimed that "exit wounds associated with AR-15 firearms are often the size of grapefruits." Rep. Lucy McBath (D-Ga) declared on Twitter that "[w]ith assault rifles, exit wounds can be a foot wide," as did a trauma surgeon with military experience quoted in the *New York Times*. That same doctor offered this hyperbolic description in another media interview:

> [A]s they travel through the body, [AR bullets] will destroy all the organs in the region of where they're traveling, and that's really due to the kinetic energy that those bullets impart. So, any centrally-fired weapon, if it hits anywhere in the central portion of the body, will blow a huge hole in a human being, particularly the exit wound, and it'll almost always be lethal. . . .

The average size of a navel orange, the most popular orange in the U.S., is three inches across, although some can grow as big as 4.5 inches in diameter. The average size of a grapefruit is four-to-six inches.

Studies have measured exit holes of .223/5.56 rounds in both gelatin testing and actual autopsy analysis. One study, using ballistic gelatin, found that the size and position of the temporary cavity influenced the size of the exit wound for 5.56mm NATO FMJ round. Testing showed that the exit hole reaches its maximum size if the bullet exits when the temporary cavity is at its maximum. The average size of the exit hole when the temporary cavity was maximized was 2.4 inches.

Another study examined 27 forensic autopsy records from persons shot with 5.56mm ammunition during dispersion of a mass protest in Bangkok in 2010. Twenty-three had typical entrance wounds. Exit wounds were various sizes and shapes, depending on the degree of bullet yaw and whether the bullet exited during the largest part of the temporary cavity. The six largest exit wounds in this group were two stellate (star) shape in the skull measuring 2.4 x 1.8 inches (6 x 4.5 cm) and 1.9 x 1.2 inches (5 x 3 cm), one stellate shape entering the back and exiting the abdomen measuring 1.2 x 1 inches (3 x 2.5 cm), one oval shape in the abdomen exiting in the lower back measuring 0.8 x 0.4 inches (2 x 1 cm), one oval shaped entering the back and exiting the chest measuring 0.8 x 0.4 inches (2 x 1 cm), and one stellate shape in the face exiting the neck measuring 0.6 x 0.4 inches (1.5 x1 cm). The remaining 17 bullets in this group either exited the body without yaw, fragmented, or left no exit wounds at all. Exit wounds were small round or oval shapes measuring less than 0.4 in (1 cm).

Nine persons suffered atypical entrance wounds from bullets that destabilized before hitting the body either by ricochet or hitting an intermediate target, causing the bullets to enter the body either sideways or at an angle. One entered the skull with the resulting exit wound having stellate shape measuring 2.9 x1 inches (7.5 x 5 cm). Another entered the lateral chest and exited the anterior chest with a stellate shape measuring 2.75 x 2.4 inches (7 x 6 cm). Two others hit extremities, one in the forearm and the other in the thigh, both with oval shaped exit wounds measuring 1.5×0.8cm (0.6 x .3 cm) and 1.2 x 0.7 cm (0.5 x 0.3 in), respectively. Of the remaining five, two caused head lacerations but did not enter the skull and three had no exit wounds, but retained the bullet or bullet fragments.

None of the exit wounds in either study are the size of oranges or grapefruits.

Such misreporting is nothing new. Thirty-three years ago, Dr. Fackler described how media accounts embellished the injuries suffered by five children murdered in the 1989 elementary school shooting in Stockton, California, one of the first modern mass shootings; the crime created the national "assault weapon" controversy. Dr. Fackler did ballistics testing on the ammunition used in the criminal's semiautomatic AKM-56S rifle, whose rounds are larger than the .223/5.56mm

rounds that are most often used in ARs. Dr. Fackler also reviewed the autopsies of the children killed. He explained:

Much of the media coverage generated by the Stockton shooting has contained misstatements and exaggerations. The myth of "shock waves" resounding from these "high velocity" bullets "pulverizing bones and exploding organs" (even if they were not hit by the bullet) "like a bomb" going off in the body was repeated by the media, in certain cases even after they were furnished solid evidence that disproved these absurdities. None of the autopsies showed damage beyond the projectile path.

One "expert" was quoted as stating that the death rate from "assault weapons . . . approaches 50[%]." Another, reporting on the effects of "high speed" bullets, stated that "most of those hit in an extremity will end up with amputations. If you're hit in the trunk, it becomes a lethal injury. . ." In the Stockton schoolyard, the death rate was 14% and none of the [wounded] victims died later or required extremity amputation.

Judges should think twice about relying on unsworn, anecdotal, and hyperbolic statements gleaned from media articles produced by gun prohibition advocates.

III.B.3. *"the injury along the path of the bullet from an AR-15 is vastly different from a low-velocity handgun injury."*

This statement is generally correct, but can be misleading without more context. Rifle bullets typically do more damage to tissue than handgun bullets, but not always so, depending on where the bullets strike. A handgun round to the brain, spinal cord, heart, or other vital organ almost always will cause more serious damage than a rifle round to an extremity or other non-vital part of the torso. As Dr. Rhee explains, "[m]ost experienced trauma surgeons will testify that what part of the body is hit by [the] gun is more important than the size of the gun."

To classify a firearm as exceptionally lethal, there must be a baseline for comparison. Ban advocates and some courts attempt to make "assault weapons" like the AR seem unusually dangerous by comparing them to handguns, as seen in the quote above. The AR does fire higher-velocity bullets that impact with much greater force than handguns, but that is true of virtually *all* rifles. That handguns generally are less terminally effective than rifles is nothing new. But comparing the effects of AR bullets to handgun bullets to prove the exceptional lethality of "assault weapons" is like comparing a Prius to a Model T to prove the Prius is much faster than average automobiles.

Media articles that describe massive wounds from "assault weapons"—such as the ones quoted above—almost never describe or compare wounds caused by larger-caliber rifles or shotguns. The AR's wounding power is no more devastating than common hunting rifles, and typically less so (partly because its bullets are smaller).

Dr. Fackler observes that at close range "the [twelve-gauge] shotgun (using either buckshot or a rifled slug) is far more likely to incapacitate than is a .223 rifle. The shotgun is simply a far more powerful weapon." Dr. P. K. Stefanopoulos, trauma surgeon and former career military officer who has written extensively on wound ballistics, confirms that at distances of less than ten feet "the shotgun produces the most devastating injuries of all small arms."

We agree that AR rifles, like every firearm, are dangerous when misused. The notion that AR rifles are unusually powerful compared to other rifles is false. Wounds caused by the AR typically are not more serious or lethal than wounds caused by larger-caliber hunting rifles, shotguns, and even some powerful handguns. These are demonstrable facts, supported by genuine firearms and wound ballistics experts.

This post was updated on March 20, 2023, for technical corrections in the last paragraph of II.A. and the history of twist rates in II.E.