Extended-Range Chemical Weapon

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Definition

An extended-range chemical weapon (ERCW) is a launcher-based less-lethal system that delivers a chemical irritant at distance through a projectile designed to strike, rupture, disperse, or otherwise release an irritant payload at or near a targeted person or localized area.

This category includes:

- PepperBall-type launchers;
- FN 303-type launchers when firing irritant-bearing projectiles;
- .68-calibre or comparable frangible irritant projectiles;
- projectiles containing oleoresin capsicum (OC);
- projectiles containing PAVA or related capsaicinoids;
- projectiles containing CS or comparable irritants; and
- similar systems combining a projectile impact with localized chemical dispersal.

It excludes:

- handheld OC or chemical spray, which is classified as Handheld Chemical Spray;
- 37 mm, 40 mm, or ARWEN systems firing pure kinetic impact rounds, which are classified as Extended-Range Impact Weapons;
- 12-gauge kinetic munitions, which are classified as Less-Lethal Shotgun; and
- area-saturation gas canisters, grenades, or fogging systems, which are classified as Tear Gas.

This definition corresponds with the research dataset, where `I_ERCW` is coded when an officer discharges a PepperBall launcher, FN 303 system, or similar platform deploying a combined kinetic/chemical payload directly at or near the decedent.

How It Is Designed to Work

Extended-range chemical weapons combine two distinct mechanisms: kinetic impact from the projectile and chemical irritation after the projectile ruptures or releases its payload. The intended operational effect is therefore different from both handheld OC spray and a pure impact munition.

Kinetic component

A projectile striking the body can produce localized pain, distraction, temporary motor inhibition, interruption of behaviour, or a startle effect. The magnitude of this effect depends on projectile mass, velocity, construction, firing distance, anatomical target, and impact angle.

Chemical component

When the projectile ruptures, its payload can produce:

- intense eye and skin irritation;
- tearing;
- involuntary eye closure;
- coughing;
- burning of the nose and throat;
- subjective breathing difficulty;
- disorientation; and
- pain sufficient to encourage compliance or withdrawal.

Depending on the platform, the chemical may affect the person struck directly, persons immediately adjacent to the impact, a small localized area, or anyone passing through the residual irritant cloud.

The defining feature: dual mechanism

This category should not be described simply as pepper spray at longer range. The projectile adds a second injury pathway, such that a successful deployment may expose a person to blunt projectile trauma in addition to chemical irritation, rather than chemical irritation alone. That distinction is central to the safety evidence.

ERCW Is Not a Single Homogeneous Technology

The category includes systems that differ materially in:

- propulsion;
- projectile construction;
- energy;
- payload;
- accuracy;
- magazine capacity;
- intended range; and
- whether direct body impact is necessary for chemical delivery.

A frangible PepperBall-type projectile and an FN 303 fin-stabilized projectile are not mechanically identical, and some platforms are designed primarily to create a localized irritant cloud while others deliberately combine meaningful impact energy with a chemical payload. Accordingly, evidence should be interpreted at two levels: platform-specific evidence, where the exact launcher and projectile are known, and class-level evidence, where studies address chemical-irritant projectiles more generally. Evidence from one platform should not automatically be converted into a precise risk estimate for another.

Evidence of Effectiveness

Overall assessment

The peer-reviewed evidence base for ERCWs is substantially thinner than the literature for handheld OC spray, conducted energy weapons, batons, or police service dogs, and that gap is itself an important finding. The available evidence is weak for real-world operational effectiveness while moderate for mechanism characterization, selected platform performance, and injury potential. There is no strong body of independent peer-reviewed literature establishing a reliable real-world success rate for PepperBall or FN 303 deployment in ordinary police encounters.

Intended operational advantage

The principal theoretical advantage over handheld chemical spray is distance. An ERCW may allow an officer to deliver irritant effects without approaching to the short ranges commonly associated with handheld OC, with potential operational advantages including maintained separation from a resistant person, application of a chemical agent from behind cover, the ability to affect a person partially protected by distance or barriers, targeting of a localized area rather than contaminating a large environment, repeated deployment without physically closing distance, and the combination of pain from impact with chemical irritation. These characteristics make the technology intuitively attractive for armed or high-risk encounters, but plausible tactical value is not the same as demonstrated field effectiveness.

FN 303 human-factors evidence

Taverniers and Suss (2019) conducted one of the few peer-reviewed experimental studies directly examining a dedicated less-lethal launcher. Sixteen participants used an FN 303 under optimal laboratory conditions and under a psychologically and physiologically demanding simulated operational condition. Under operational stress, subjective workload and cortisol secretion both increased, overall shooting accuracy deteriorated, and the degradation was most pronounced on the vertical axis. That last finding is especially important because vertical error can transform an intended lower-body strike into a chest, neck, or head strike. The study therefore provides evidence that performance measured on a static range may overstate accuracy under operational stress, but it does not provide a real-world incapacitation rate.

Broader police data

The recent review by Nielsen and colleagues [(Nielsen et al., 2025)] found that PepperBall launchers appeared in some police use-of-force datasets only as part of a composite less-lethal category alongside OC spray, CEWs, less-lethal rifles, less-lethal shotgun ammunition, and riot shields. That composite category was associated with lower subject-injury risk than broader physical-force categories. Because PepperBall was not isolated, however, these studies cannot answer whether the launcher itself reduced injury, increased injury, successfully incapacitated subjects, or prevented escalation. The same limitation applies to Petersen and colleagues [(Petersen et al., 2025)], where broad less-lethal groupings prevent clean platform-specific inference.

What is missing

The literature does not currently provide reliable independent estimates for the outcomes listed below, a gap large enough that it should be considered a substantive finding of the evidence library:

- first-shot success;
- overall encounter-resolution success;
- number of projectiles typically required;
- probability of obtaining voluntary compliance;
- probability of physical incapacitation;
- probability of preventing firearm use;
- probability of preventing officer injury;
- effectiveness against persons armed with edged weapons;
- comparative effectiveness versus handheld OC;
- comparative effectiveness versus CEW;
- comparative effectiveness versus 40 mm impact rounds; or
- failure rates by distance.

Injury and Safety Evidence

Two independent injury pathways

ERCWs create two analytically separate injury mechanisms.

1. Projectile trauma

The projectile can cause bruising, abrasions, laceration, hematoma, ocular trauma, fracture, blunt internal injury, or penetrating injury in extreme circumstances.

2. Chemical exposure

The irritant can cause ocular pain, tearing, conjunctival irritation, skin burning, coughing, respiratory irritation, anxiety or panic, and secondary contamination of nearby people. The total risk is therefore not captured by studying handheld OC alone.

Systematic evidence on chemical-irritant projectiles

Haar and colleagues (Haar et al., 2017a) systematically reviewed injuries associated with chemical irritants used in crowd-control settings. Among the included studies, seven recorded injuries caused by projectile munitions containing chemical irritants. Across the review, projectile-related trauma accounted for 231 injuries, of which 63 (27%) were classified as severe. Documented severe projectile injuries included major head trauma, globe rupture, blindness, traumatic brain injury, limb injury, and permanent disability; one documented death involved traumatic brain injury after impact from a chemical-irritant projectile.

These figures must not be interpreted as a 27% severe-injury probability per ERCW deployment. The review included people who sought medical attention and covered multiple forms of chemical-irritant munitions. Its value is to establish that the projectile component of a chemical weapon can produce severe or fatal mechanical trauma independently of the chemical payload.

Ophthalmic injury

Ifantides and colleagues (2020) examined ophthalmic injuries associated with less-lethal kinetic projectiles during the 2020 George Floyd protests, recovering or identifying projectiles including rubber baton rounds, foam projectiles, and pepper balls. One documented patient struck by a PepperBall suffered periorbital edema, subconjunctival hemorrhage, hyphema, and commotio retinae; other kinetic-projectile patients in the same clinical series experienced ruptured globes, orbital fractures, severe vision loss, and enucleation. The study could not identify the exact projectile in every case, which limits PepperBall-specific attribution, but it strongly supports the broader proposition that the eye is an exceptionally vulnerable target for small high-velocity projectiles.

Direct PepperBall ocular case

Chacko, Fong, and Davis (2021) reported a direct PepperBall ocular injury involving a 10 mm scleral rupture, uveal prolapse, total retinal detachment, full-thickness eyelid injury, orbital wall fracture, severe retrobulbar hemorrhage, and no-light-perception vision at presentation. The authors attributed the injury to both direct projectile trauma and capsaicinoid chemical exposure. This is a single case and cannot establish injury probability, but it does establish that a PepperBall projectile can produce catastrophic ocular injury.

Chemical component

The chemical component of an ERCW shares relevant toxicologic features with handheld OC or related irritants. Busker and van Helden (Busker & Van Helden, 1998) found a generally favourable toxicologic profile for

pepper spray under expected use conditions, and Semple, Jenkins, and Bennell (Semple et al., 2021) likewise concluded that OC is generally effective and associated with relatively low injury risk. Those findings support the chemical payload component of ERCW safety but do not establish that the projectile delivery system is equally low-risk – a distinction that is essential to the analysis.

Anatomical Location Matters

The anatomical target strongly affects injury severity. Particularly vulnerable regions include the eye, face, temple, head, neck, throat, and chest. A projectile intended to rupture against clothing or a large muscle mass can produce a radically different outcome if it strikes the eye.

Head and neck

The broader kinetic-projectile literature consistently associates head and neck impacts with disproportionate rates of severe injury, permanent disability, and death. Haar and colleagues' kinetic-impact systematic review (Haar et al., 2017b) found that head and neck strikes accounted for a large share of fatal and permanently disabling outcomes. Although that review includes projectiles more powerful than many PepperBall rounds, the anatomical principle remains relevant.

Eye

The eye is especially vulnerable because it has little protective soft tissue, globe rupture can occur from blunt impact, orbital structures can fracture, the projectile may concentrate energy over a small area, and chemical irritant can complicate the injury. Direct fire at the face should therefore be understood as qualitatively different from deployment toward a lower-risk target or nearby surface.

Accuracy and Operational Stress

Accuracy is a safety mechanism: the harm-reduction premise of a projectile weapon assumes officers can place rounds where policy intends. Taverniers and Suss (2019) demonstrated that operational stress degraded FN 303 accuracy even when participants engaged a static target at 30 metres, and the deterioration in vertical accuracy is particularly significant because training commonly depends on officers avoiding head, neck, and other vulnerable targets. A weapon may be mechanically accurate while still becoming meaningfully less accurate in the hands of a stressed operator. Training and qualification should therefore account for stress, movement, reduced visibility, realistic protective equipment, moving subjects, and decision-making under time pressure.

Cross-Contamination and Environmental Risk

Although more localized than tear gas, ERCWs can still expose unintended people. Chemical payload may affect nearby officers, victims, bystanders, people downwind, or persons entering the contaminated area

afterward. Risk depends on wind, ventilation, number of rounds, payload, whether the environment is enclosed or open, proximity of third parties, and whether rounds are directed at a person or used for localized area saturation. Repeated fire can change the character of the intervention: a few targeted irritant projectiles may function as individual less-lethal force, while large numbers fired into a confined or crowded environment can begin to function more like area chemical deployment.

When Its Use May Be Appropriate

The evidence does not establish a universal deployment threshold. ERCW use is most defensible where a person presents active resistance or a meaningful safety threat, officers benefit from maintaining distance, handheld chemical spray would require an unsafe approach, officers can identify an appropriate target area, third-party contamination can reasonably be limited, there is enough tactical margin to tolerate incomplete effect, and successful deployment could prevent a more injurious intervention. Potentially appropriate circumstances include a violent but contained subject, a person refusing to relinquish a weapon while officers maintain cover, active resistance occurring beyond handheld-spray range, a subject whose location makes close physical contact unnecessarily hazardous, or a tactical operation where officers can immediately transition to another option if ERCW deployment fails. The technology's strongest rationale is distance plus reduced expected lethality, not guaranteed incapacitation.

When Its Use May Be Inappropriate

Passive or verbal resistance

The combination of projectile impact, substantial pain, and chemical irritation is difficult to justify solely because a person is verbally noncompliant or passively resistant.

Immediate lethal assault without tactical margin

ERCW deployment should not be assumed to provide firearm-equivalent stopping reliability, and the available peer-reviewed literature does not establish a dependable incapacitation rate against armed subjects. In a rapidly developing edged-weapon assault, relevant considerations include subject distance, closing speed, reaction time, availability of cover, availability of lethal-force backup, target exposure, and whether failed deployment can be safely absorbed. The fact that the launcher works at longer range than handheld OC does not mean its chemical component works instantaneously.

Head, face, or neck targeting

Direct fire at vulnerable anatomy can produce severe mechanical injury independently of the chemical payload. Intentional head or face targeting materially changes the risk profile and may approach deadly-force levels depending on the projectile, distance, and circumstances.

Uncontrolled crowds

Firing projectiles into a crowd creates increased risk of striking a non-threatening person, striking an unintended anatomical target, exposing uninvolved people to chemical irritant, and losing individual control over who receives force.

Enclosed environments

Repeated chemical-projectile deployment in confined spaces can increase concentration and collateral exposure.

Repeated rounds after control

A high-capacity or semi-automatic launcher can permit rapid repeated fire, and that capability should not be confused with continuing justification. Each projectile remains a separate application of force requiring a continuing governmental need.

Relevance to Edged-Weapon Encounters

Extended-range chemical weapons may be particularly attractive in edged-weapon encounters because they preserve more distance than handheld spray while attempting to avoid firearm-level injury. The evidence base, however, is too weak to establish a dependable incapacitation rate against armed subjects.

Potential role

An ERCW can potentially deliver irritant effects without requiring officers to enter handheld-spray range, add localized impact or pain, interrupt behaviour, encourage surrender or withdrawal, and allow officers to remain behind cover while attempting a lower-lethality intervention. This makes the technology conceptually useful in contained armed-person incidents where officers have time and distance.

Conditions favouring deployment

Deployment is more plausible where the subject is contained rather than already attacking, officers have cover, the launcher can be aimed at an appropriate lower-risk area, there is enough distance to tolerate incomplete chemical effect, collateral contamination can be limited, and officers have a transition option if the device fails.

Failure consequences

ERCWs combine a projectile mechanism with a chemical mechanism, but neither guarantees incapacitation. The subject may remain capable of moving after impact, experience irritation without losing weapon capability, be missed entirely, or receive only partial exposure. Operational stress can also degrade launcher accuracy, increasing the possibility of ineffective placement or an unintended vulnerable-area strike. In a rapidly developing edged-weapon assault, those limitations may leave insufficient time for a second intervention.

Risk trade-off

For the subject, the device may reduce the expected harm associated with firearm use but introduces both chemical exposure and projectile injury. For officers and third parties, the principal risk is mistaking extended range for dependable stopping capability. ERCW use is therefore most defensible when officers have enough distance, cover, containment, and transition capability to manage failure. The current evidence does not support relying on ERCW as a stand-alone response to an immediately advancing edged-weapon threat.

U.S. Legal Considerations

Fourth Amendment framework

ERCW deployment during a seizure is generally analyzed under *Graham v. Connor* and the totality of the circumstances. Relevant factors include the severity of the suspected offense, whether the person poses an immediate threat, active resistance or flight, the amount of force represented by the projectile, anatomical target, whether warning was given, availability of less intrusive alternatives, and whether force is individualized or directed indiscriminately toward a group. The law does not treat the term "less lethal" as dispositive.

Nelson v. City of Davis

Nelson v. City of Davis, 685 F.3d 867 (9th Cir. 2012) is the most important federal appellate decision specifically involving PepperBall projectiles. Police officers attempting to disperse a large party fired PepperBall rounds toward a group of students, and Timothy Nelson – who according to the summary-judgment record was unarmed and compliant – was struck in the eye and permanently injured. The Ninth Circuit held that the projectile strike constituted a Fourth Amendment seizure, that firing PepperBall rounds under the circumstances could constitute excessive force, and that the officers were not entitled to qualified immunity because the constitutional violation was clearly established. The case is especially significant because the court recognized that PepperBall combines kinetic projectile impact and OC chemical effects, rather than treating it as merely a distant form of pepper spray.

Warning and opportunity to comply

Nelson also emphasized that officers had not provided an effective audible warning or clear means for the students to comply before projectiles were fired. Where circumstances permit, meaningful warning and a realistic opportunity to comply weigh heavily in the reasonableness analysis before projectile force is used.

Peaceful or non-threatening subjects

The constitutional rule becomes particularly strong where the targeted person is non-threatening, compliant, not actively resisting, has committed no serious offense, or is merely present near others who are violating the law.

Tenth Circuit: contemporary qualified-immunity law

In *Packard v. City and County of Denver* (10th Cir. 2026), the Tenth Circuit affirmed a verdict against an officer who shot a peaceful, non-threatening protester with a PepperBall, holding that precedent had clearly established by 2020 that police violate the Fourth Amendment when they shoot peaceful, non-threatening protesters with less-lethal munitions. The decision reinforces that qualified immunity does not protect indiscriminate PepperBall use against a person who does not present a meaningful threat.

Threatening or actively unlawful conduct

The legal analysis changes materially where a subject actively assaults officers, presents an immediate physical threat, violently resists, uses or attempts to use a weapon, or engages in conduct creating imminent danger to others. ERCW force may be reasonable in such circumstances when proportionate and properly targeted. Legality remains dependent on what the individual subject is doing, not simply on the fact that a crowd or surrounding group is disorderly.

Ethical and Moral Considerations

ERCWs raise a particularly important ethical issue because they combine two forms of imposed harm: the targeted person may receive blunt projectile impact and chemical pain with sensory impairment, and the ethical justification must therefore account for that combined burden rather than treating the intervention as equivalent to ordinary pepper spray deployed at a distance.

Harm substitution

The strongest ethical case exists where ERCW use plausibly substitutes for baton force, canine deployment, close physical struggle, stronger kinetic impact munitions, or firearm use. The justification is weaker when the realistic alternative is time, distance, communication, cover, containment, negotiation, or no force.

Accuracy as an ethical obligation

Because serious injury risk changes dramatically with anatomical target, accuracy is not merely a technical consideration but part of the ethical justification for the weapon. If stress predictably degrades an officer's ability to keep rounds away from the head and neck, then training, qualification, firing distance, target selection, and deployment context become moral as well as operational considerations.

Collateral exposure

Chemical payload can affect people whom officers did not intend to use force against. This is especially relevant in crowds, confined spaces, domestic environments, scenes involving children, and situations where victims or hostages are close to the subject.

Rapid repeated fire

Some ERCW platforms permit rapid multiple rounds, which can be operationally useful but also creates risk that officers will transition from targeted force to volume-based force without reassessing whether each additional projectile is justified.

Evidence uncertainty

The limited independent evidence base creates an additional ethical obligation: where a technology is less thoroughly studied, policy should avoid treating manufacturer claims or intuitive tactical benefits as settled science.

Evidence Limitations

The ERCW evidence base is notably weak across several dimensions. First, there are very few independent peer-reviewed studies isolating PepperBall or comparable chemical-projectile systems. Second, real-world effectiveness denominators are largely absent, and there is no reliable independent first-shot or encounter-resolution rate. Third, many police datasets aggregate PepperBall with other less-lethal interventions. Fourth, evidence supporting OC chemical safety cannot automatically be generalized to the projectile component. Fifth, broad kinetic-projectile research includes munitions with substantially greater energy than some ERCW systems. Sixth, platform differences are substantial, and PepperBall and FN 303-type systems should not be assumed to have identical risk. Seventh, crowd-control studies dominate much of the medical evidence, while patrol and tactical deployments are less studied. Eighth, serious eye injuries are well documented but cannot be converted into an incidence rate without deployment denominators. Ninth, operational-stress research indicates degraded accuracy, but realistic studies remain rare and small. Tenth, evidence specific to edged-weapon encounters is essentially absent. For this evidence library, ERCW should therefore carry one of the strongest research-gap warnings among established police less-lethal weapons.

Bottom Line

Effectiveness

Low direct evidence. ERCWs offer plausible tactical advantages through distance and combined kinetic/chemical effects, but independent peer-reviewed studies do not provide a reliable real-world success or incapacitation rate.

Injury

Dual-mechanism injury risk. Most chemical effects are temporary, but the projectile component can cause blunt trauma, ocular injury, and other serious physical harm.

Serious injury/death

Clearly possible but poorly quantifiable. Catastrophic eye injury is documented, and broader chemical-projectile literature includes permanent disability and fatal projectile trauma.

Comparative safety

Not adequately quantified. It is scientifically inappropriate to assume that ERCWs inherit the low injury rate of handheld OC because they add a projectile mechanism.

Accuracy

Operational stress matters. Experimental FN 303 research demonstrates degraded accuracy under simulated high-pressure conditions, including vertical error relevant to unintended vulnerable-area impacts.

Tactical limitation

Extended range does not equal reliable immediate incapacitation. A person may remain physically capable of acting after impact and/or chemical exposure.

Risk-benefit assessment

The strongest justification for ERCW use is a threatening but tactically controlled encounter where greater distance reduces officer exposure, accurate lower-risk targeting is feasible, collateral contamination can be limited, and officers can safely manage failure. Its weakest justification is against passive or verbal resistance, indiscriminately in crowds, toward the head or face, or in an immediate lethal assault where unsuccessful incapacitation would leave no tactical margin.

Core Peer-Reviewed Evidence

1. Taverniers, J., & Suss, J. (2019)

A user-centred assessment of a less-lethal launcher: the case of the FN 303® in a high-pressure setting. *Ergonomics, 62*(9), 1162–1174.
DOI: 10.1080/00140139.2019.1626916

Priority: Essential / strongest platform-specific human-factors study.

Contribution: Within-subject field experiment involving 16 participants using the FN 303 under laboratory and simulated operational conditions.

Key finding: Operational stress increased workload and cortisol and significantly reduced shooting accuracy.

Safety finding: Accuracy deteriorated particularly on the vertical axis, creating direct relevance to unintended head/neck impacts.

Conflict disclosure: The authors reported no potential conflict of interest.

Limitation: Small simulated study; does not measure real-world incapacitation or injury.

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2. Haar, R. J., Iacopino, V., Ranadive, N., Dandu, M., & Weiser, S. D. (2017)
Health impacts of chemical irritants used for crowd control: a systematic review of the injuries and deaths caused by tear gas and pepper spray.
BMC Public Health, 17, 831.
DOI: 10.1186/s12889-017-4814-6

Priority: Essential safety synthesis for chemical-projectile injury.

Contribution: Systematic review of 31 studies involving chemical-irritant exposure.

Projectile finding: Seven included studies reported injuries from projectile munitions containing chemical irritants.

Key finding: Projectile trauma accounted for 231 injuries, with 63 classified as severe.

Serious outcomes: Documented injuries included blindness, globe rupture, traumatic brain injury, limb loss, and permanent disability; one death involved traumatic brain injury from a chemical-irritant projectile.

Limitation: Combines multiple chemical agents and projectile systems and samples medically affected populations rather than all deployments.

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3. Ifantides, C., et al. (2020)
Ophthalmic Injuries by Less-Lethal Kinetic Weapons During the US George Floyd Protests in Spring 2020.
JAMA Ophthalmology, 138(12), 1353–1355.
DOI: 10.1001/jamaophthalmol.2020.5325

Priority: High direct injury evidence.

Contribution: Surveyed ophthalmology programs and described detailed ocular trauma associated with less-lethal projectiles during 2020 protests.

PepperBall finding: One documented PepperBall patient sustained hyphema, commotio retinae, subconjunctival hemorrhage, and periorbital injury.

Broader finding: Kinetic projectiles were associated with globe rupture, orbital fracture, major vision loss, and enucleation.

Limitation: Exact projectile type could not be established in every case.

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4. Chacko, J., Fong, J., & Davis, R. (2021)

Pepper-Ball-Related Ocular Injury.

Clinical and Experimental Ocular Trauma and Infection, 3(1), 12–15.

Priority: Important platform-specific case evidence.

Contribution: Direct case report of severe PepperBall ocular trauma.

Key finding: Injury included scleral rupture, uveal prolapse, total retinal detachment, eyelid damage, orbital fracture, retrobulbar hemorrhage, and profound vision loss.

Key value: Demonstrates catastrophic injury potential from the combined projectile and chemical mechanism.

Limitation: Single case; no DOI located and no incidence inference is possible.

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5. Nielsen, M., Munkholm, J., Banner, J., & Wingren, C. J. (2025)

Injury rates following conducted electrical weapons and other less-lethal force modalities in real-life police settings: a comparative literature review.

Forensic Science, Medicine and Pathology, 21, 1396–1406.

DOI: 10.1007/s12024-025-01020-9

Priority: Important comparative synthesis.

Contribution: Reviews 19 peer-reviewed studies of real-world police force.

ERCW relevance: Some source studies included PepperBall launchers within a composite less-lethal category.

Key finding: Composite less-lethal force was generally associated with lower injury than broader physical-force categories.

Critical limitation: PepperBall outcomes were not isolated, preventing device-specific causal inference.

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6. Petersen, K., Koper, C. S., Taylor, B. G., Liu, W., & Sheridan-Johnson, J. (2025)

Less-Lethal Weapons and Civilian Injury in Police Use of Force Encounters: A Multi-agency Analysis.

Journal of Urban Health, 102(2), 389–399.

DOI: 10.1007/s11524-024-00940-1

Priority: Supporting modern comparative evidence.

Contribution: Multi-agency use-of-force analysis involving 2,348 incidents.

Key value: Places broad less-lethal modalities within a modern comparative injury framework.

Limitation: PepperBall and related platforms are grouped with other force technologies and cannot be independently evaluated.

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7. Semple, T., Jenkins, B., & Bennell, C. (2021)

Injuries and deaths proximate to oleoresin capsicum spray deployment: A literature review.

The Police Journal: Theory, Practice and Principles, 94(2), 184–205.

DOI: 10.1177/0032258X20926873

Priority: Supporting chemical-payload safety evidence.

Contribution: Reviews injury and mortality evidence associated with OC exposure.

Key finding: OC is generally associated with low rates of serious direct injury and reduced odds of subject and officer injury.

ERCW relevance: Supports the chemical component only.

Critical limitation: Does not establish the safety of a projectile delivery mechanism.

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8. Busker, R. W., & van Helden, H. P. M. (1998)

Toxicologic Evaluation of Pepper Spray as a Possible Weapon for the Dutch Police Force: Risk Assessment and Efficacy.

American Journal of Forensic Medicine and Pathology, 19(4), 309–316.

DOI: 10.1097/00000433-199812000-00003

Priority: Supporting chemical-mechanism evidence.

Contribution: Toxicologic and efficacy assessment of pepper spray.

Key value: Supports a generally favourable toxicologic profile for capsaicinoid chemical exposure.

Critical limitation: Handheld chemical exposure does not include the kinetic injury mechanism of ERCW projectiles.

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9. Haar, R. J., Iacopino, V., Ranadive, N., Dandu, M., & Weiser, S. D. (2017)

Death, injury and disability from kinetic impact projectiles in crowd-control settings: a systematic review.

BMJ Open, 7(12), e018154.

DOI: 10.1136/bmjopen-2017-018154

Priority: Supporting kinetic-component safety evidence.

Contribution: Systematic review of 26 studies involving 1,984 people injured by kinetic impact projectiles.

Key finding: Serious injury, permanent disability, and death were disproportionately associated with head and neck impacts.

ERCW relevance: Establishes the general importance of anatomical target for projectile force.

Critical limitation: Many reviewed projectiles have substantially different energy and construction from PepperBall-type rounds.

Evidence Rating

Operational effectiveness: ★★☆☆☆
Very little independent real-world denominator-based research.

General injury evidence: ★★★☆☆
Chemical and kinetic injury mechanisms are individually well supported, but ERCW-specific incidence data are sparse.

Serious-injury probability: ★★☆☆☆ to ★★★☆☆
Severe injury is clearly possible, especially ocular injury, but absolute probability cannot be reliably estimated.

Mortality evidence: ★★☆☆☆
Fatal chemical-projectile trauma is documented in broader literature, but platform-specific mortality evidence is extremely limited.

Comparative evidence: ★★☆☆☆
Most datasets aggregate ERCW with other force modalities.

Accuracy/human-factors evidence: ★★★☆☆
A valuable FN 303 study demonstrates stress-related accuracy degradation, but replication and field studies are needed.

Platform-specific evidence: ★★☆☆☆
One of the least-developed evidence bases among established less-lethal weapon classes.

Overall confidence: Low-to-moderate.

Research-library conclusion

Extended-range chemical weapons combine a tactical advantage – chemical delivery from greater distance – with a second injury mechanism that handheld OC spray does not have: projectile impact. That dual mechanism means these systems should not inherit the favourable safety profile of handheld OC by assumption. Available peer-reviewed evidence demonstrates that chemical-projectile impacts can produce

severe ocular and other traumatic injuries, while FN 303 human-factors research shows that operational stress can degrade shooting accuracy in precisely the direction that increases the risk of unintended vulnerable-area strikes. At the same time, independent real-world evidence on first-shot effectiveness, encounter resolution, and injury probability is remarkably sparse. ERCWs therefore represent a significant evidence gap. Their strongest justification is in threatening but tactically controlled encounters where extended range meaningfully reduces officer exposure, officers can target lower-risk anatomy, collateral chemical exposure is limited, and failure can be safely managed. Their weakest justification is against passive or verbal resistance, indiscriminately in crowds, toward the head or face, or in immediate lethal-threat encounters where there is no margin for incomplete or delayed effect.

References

Busker, R. W., & Van Helden, H. P. M. (1998). Toxicologic Evaluation of Pepper Spray as a Possible Weapon for the Dutch Police Force: Risk Assessment and Efficacy. *The American Journal of Forensic Medicine and Pathology*, *19*(4), 309–316. https://doi.org/10.1097/00000433-199812000-00003

Haar, R. J., Iacopino, V., Ranadive, N., Weiser, S. D., & Dandu, M. (2017a). Health impacts of chemical irritants used for crowd control: a systematic review of the injuries and deaths caused by tear gas and pepper spray. *BMC Public Health*, *17*(1), 831. https://doi.org/10.1186/s12889-017-4814-6

Haar, R. J, Iacopino, V., Ranadive, N., Dandu, M., & Weiser, S. D. (2017b). Death, injury and disability from kinetic impact projectiles in crowd-control settings: a systematic review. *BMJ Open*, *7*(12), e018154. https://doi.org/10.1136/bmjopen-2017-018154

Nielsen, M., Munkholm, J., Banner, J., & Wingren, C. J. (2025). Injury rates following conducted electrical weapons and other less-lethal force modalities in real-life police settings: a comparative literature review. *Forensic Science, Medicine and Pathology*, *21*(3), 1396–1406. https://doi.org/10.1007/s12024-025-01020-9

Petersen, K., Koper, C. S., Taylor, B. G., Liu, W., & Sheridan-Johnson, J. (2025). Less-Lethal Weapons and Civilian Injury in Police Use of Force Encounters: a Multi-agency Analysis. *Journal of Urban Health*, *102*(2), 389–399. https://doi.org/10.1007/s11524-024-00940-1

Semple, T., Jenkins, B., & Bennell, C. (2021). Injuries and deaths proximate to oleoresin capsicum spray deployment: a literature review. *The Police Journal: Theory, Practice and Principles*, *94*(2), 184–205. https://doi.org/10.1177/0032258X20926873

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