

Toys that look identical aren't identically safe, biomechanics experts say

November 15 2017



The foam darts being shot by this tester have virtually no eye-injury risk. But inexpensive knockoff versions are more dangerous, according to research from the Virginia Tech Helmet Lab. Credit: Virginia Tech

The popularity of the Nerf "blaster" toy gun has created an active market

for inexpensive off-brand versions of the Nerf darts, but new data from Virginia Tech suggests that the off-brand darts are two to three times more likely to cause eye injuries.

Nerf darts are small foam cylinders with rubbery tips, and the off-brand ones look nearly identical to the real thing.

The research was directed by Stefan Duma, the Harry Wyatt Professor of Engineering in the College of Engineering and an expert on injury biomechanics.

Earlier this year, a British journal described three cases of eye injury caused by Nerf blasters. These were the first literature reports of serious risks with these toys, which have generally been regarded as safe.

The study caught Duma's attention. His lab at the Institute for Critical Technology and Applied Science, where Duma is the interim director, has been evaluating the eye-injury risk of consumer products for more than a decade. Duma's research team has tested a wide range of toys, including the Nerf blasters implicated in the British study.

Duma noticed that at least one patient in the study had loaded the toy with off-brand darts, and wondered if variation between different brands of darts could be responsible for the injuries.

To test the hypothesis, researchers Abi Tyson and Bethany Rowson assessed the injury risk of Nerf darts alongside six other brands. All the darts functioned similarly in the blaster, but the experiments revealed critical differences.

The eye injury risk of a projectile depends on its mass, its velocity, and how large a cross-section it hits when it contacts the body. The larger the impact area, the less force is exerted on any one section of tissue.

That's why a soft projectile is typically less dangerous than a firmer one of equal mass: it compresses upon impact, widening the impact area and distributing the force.

"The Nerf products are designed very carefully so that when the dart hits a surface, like your eye, it compresses. The more area that contacts your eye, the lower the stress, because you spread the force out," Duma explained.

"That's one factor. The other part is that the Nerf darts are lighter. If you take the same velocity, but add mass and a more rigid tip, you end up with higher stresses on the eyes."

The researchers used two methods to determine the darts' injury risk.

First, they measured the darts' mass, velocity, and area of impact to calculate a value called normalized energy, which is known to be the best predictor of eye injury.

They also shot the darts at a dummy headform embedded with impact sensors. Duma's team originally developed this tool, called the FOCUS headform, as a physical model to study blast injuries in the military.

Made of materials that mimic the stiffness of a human eye and its surrounding tissue, it allows researchers to precisely measure forces exerted by a projectile on the eyes and face, determine which impacts are more likely to cause injury, and evaluate safety goggles and other protective equipment.

"It simulates the interaction between an object and a human eye, so it gives you a different way of measuring risk," Duma said.

The data from both types of tests indicated that the injury risk from the

off-brand darts was two to three times higher than the risk from the Nerf-brand darts. In fact, the Nerf darts were the only ones whose normalized energy values fell below the accepted industry standard for safety.

"Consistently, all the off-brand darts we tested were all higher risk. They might look the same, but they are different in terms of safety," Duma said. "You're doubling and tripling your risk, and you start to get into numbers that are appreciable."

Without research like Duma's, consumers would have little way of knowing about safety differences between otherwise comparable toys.

"If you have both darts, you can feel them, and tell that they're different," he said. "But if you're a mom or a dad buying these things online, there are pages and pages of them. Some of these other darts are incredibly cheap, and they look the same, so that's what people buy."

But some companies may have performed more thorough safety testing than others. So in certain cases, the brand matters—and these data suggest that Nerf darts may be one example.

Getting evidence-based information on [injury](#) risk to the public is a longstanding interest of Duma's. After years of research on head impacts in football, he developed the Virginia Tech Helmet Ratings in collaboration with assistant professor of biomedical engineering and mechanics Steve Rowson.

The ratings, which are [publicly available](#), score helmets on a five-star scale based on their ability to reduce concussion risk and were the first tool that allowed consumers to compare different helmets on the basis of safety.

"We view informing consumers on smart purchases as a critical part of

our role," Duma said. "So when this study on Nerf darts and [eye injury](#) came out, we wanted to figure out what was behind it."

The team is preparing a manuscript describing their results, which will be submitted for publication in a peer-reviewed journal.

More information: Mukhtar Bizrah et al. Nerf gun eye injuries: traumatic hyphema, *BMJ Case Reports* (2017). [DOI: 10.1136/bcr-2017-220967](#)

Provided by Virginia Tech

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