



Can School Lockdowns Save Lives? An Assessment of Drills and Use in Real-World Events

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ABSTRACT

Mass shootings in schools raise important questions about how best to keep individuals safe and increase survivability in such situations. One of the most common techniques used is lockdown drills, which train individuals to build time and space between them and the threat. Despite their use in 95% of public K-12 schools nationwide, their efficacy is regularly called into question. The present two-pronged study examines the role of lockdowns both in practice (via drills) and in real-world events to answer this question. Findings indicate that continued training and drills builds and maintains skill mastery relative to correct deployment of the lockdown procedure, while the use of these tools in real-world events like mass school shootings can have a protective effect, leading to fewer injuries and deaths. Based on these findings, implications for policymakers and school administrators tasked with keeping students and staff safe are offered.

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In the aftermath of high-profile mass shootings in schools, including the attacks at Oxford High School in Oxford, MI (2021) and Robb Elementary School in Uvalde, TX (2022), the efficacy of the practice of lockdown drills has been called into question. Erroneous claims have been made by the media that lockdowns are ineffective because they failed to prevent each of these attacks (e.g., Goldstein, 2021), and similar assertions about the practices more broadly have been made by national organizations including Everytown for Gun Safety, the American Federation of Teachers and the National Education Association (2020). Challenging such claims, however, is the fact that lockdown drills were never designed to be a prevention strategy. Instead, they are a harm mitigation practice designed to save lives if a shooting – or any danger within a school building – occurs (Schildkraut & Nickerson, 2022).

Lockdown drills, a practice currently used in more than 95% of U.S. public K-12 schools (Wang et al., 2020), became commonplace in schools following the 1999 shooting at Columbine High School in Jefferson County, CO. Even without a formalized plan in place on the day of the attack, the Columbine Review Commission (2001) credited lockdowns as saving the lives of students and teachers in the building. Despite the two perpetrators having an unprecedented 50 minutes (most mass shootings are over in five minutes or less; see, Blair & Schweit, 2014) and being armed with four guns and nearly 100 improvised explosive devices, they never tried to breach a locked door, despite there being hundreds of people still in the school during the attack. Instead, those who were killed or injured were outside, in the cafeteria, and in the library – areas that could not be locked down (Columbine Review Commission, 2001).

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Lockdown drills as a practice often are confused with options-based approaches that are used solely to respond to active shooters; strategies such as Run Hide Fight or the A.L.I.C.E. protocol may incorporate principles of lockdowns, but it often is not the main strategy taught (Schildkraut & Nickerson, 2022). Still, although there may be variability in how lockdown drills are conducted, the basic steps of the procedure are largely the same (Keyes & Deffner, 2015; Rygg, 2015). First, building occupants are directed to secure their location with a door lock, which has been credited by the Sandy Hook Advisory Commission (2015) as the most successful lifesaving device during a school shooting, to build distance between themselves and the danger. In instances where the location cannot be locked (e.g., there is no door lock present or an individual does not have the necessary keys), a barricade may be built using furniture in the room. Next, the lights are turned off to provide an added layer of concealment. Occupants then move out of sight of any interior windows and maintain silence to not call attention to their room. Like the equally common fire drills, the goal of a lockdown drill is to build muscle memory, which refers to an individual's ability to perform an action during stressful times without conscious effort (Shusterman, 2011).

Despite the widespread use of lockdown drills in U.S. schools and the commentary that surrounds their efficacy, there is a dearth of information about these practices relative to both whether the development of muscle memory, by way of skill mastery, is achieved by drills and whether their use in real-world situations save lives. First, relative to skill mastery, just three studies to date (Dickson & Vargo, 2017; Schildkraut & Nickerson, 2020; Zhe & Nickerson, 2007) have evaluated the procedural integrity of actual drills. In each study, participants were able to successfully complete the steps of the practice as they were trained, though, regardless of age, were found to struggle with maintaining silence. Two studies did find that participants' ability to remain quiet improved following the introduction of training (Dickson & Vargo, 2017; Schildkraut & Nickerson, 2020). Importantly, however, these studies each involved short experimental periods (up to six months) and did not consider whether the skill mastery built was maintained over time.

Second, regarding real-world applications of these practices, proponents of lockdown drills point to the three school shootings where anyone was killed behind a locked door (Schildkraut & Muschert, 2019). In 2005, the perpetrator at Red Lake High School in Red Lake, MN, attempted to shoot out the locks on a particular classroom but they melted and held; he was able to access the room through the adjacent window ("10 Years After Red Lake," 2015). In 2006, the perpetrator at Platte Canyon High School in Bailey, CO, was barricaded behind the locked door in the classroom with the student he killed when the SWAT team breached the room (Park County Emergency Management, 2006). In 2018, six students were killed in three locked classrooms during the shooting at Marjory Stoneman Douglas High School in Parkland, FL, though the perpetrator never entered a single room – he fired through the doors and the windows within them (Mazzei, 2018). In each of these cases, the door locks themselves never failed. Further, there were countless other students and staff throughout these school buildings who were able to fully lockdown and were physically unharmed.

Taken together, there remain important gaps related to lockdown drills that this study seeks to fill. Using a two-pronged approach, we first consider whether the use of drills can not only build skill mastery and develop muscle memory, but also sustain it over time. We then evaluate the use of lockdowns during real-world mass shootings to assess what impact their employment had on casualty outcomes. Taken together, the findings from each assessment have important implications not only for school administrators and policymakers tasked with student and staff safety, but also for the public in better understanding the efficacy of lockdowns and their associated drills.

Study 1: Lockdowns in Practice

The first study seeks to address whether the practice of lockdown drills meets its intended outcome of building skill mastery by assessing the procedural integrity of these practices relative to how many steps are correctly completed. Additionally, consideration is given not only to whether skill mastery can be built, but whether it can be maintained over time. Specifically, we assess lockdown drills over a

four-year period to overcome the limitations of previous research that focused on single drills or those conducted in abbreviated time spans.

Methods

Data for this study were collected as part of a larger project implementing an all-hazards emergency response plan (ERP) in a large urban school district, which serves more than 21,000 students and 4,300 faculty, staff, administrators, and embedded community partners, in Central New York. In the school year following the Parkland shooting (2018–19), the district's Department of Public Safety (DPS) partnered with the lead researcher to standardize the ERP across all 30 school buildings.¹ During this first year of the project, the research team conducted two lockdown drills, one prior to training on the new ERP and one after. The training was delivered in assembly-style sessions to faculty, staff, and students using pre-developed training materials from the I Love U Guys Foundation as part of the Standard Response Protocol-Extended Edition (SRP-X) program. As the state requires schools to participate in four lockdown drills per year,² the remaining two drills were used to continue practice after the research team had completed their project for the year.

The next school year (2019–20), the project focused on implementing an accompanying reunification protocol. A round of follow-up lockdown drills was conducted to assess whether the skills learned the prior school year had been maintained. In the third year of the project (2020–21), three additional drills per school were conducted once in-person learning resumed in the spring. These drills were modified slightly, with students practicing in smaller groups to allow for social distancing due to the pandemic to ensure health safety. Finally, in the most recent school year (2021–22), the research team conducted each building's four state mandated drills. In total, data were collected on 288 lockdown drills across the four years.³

Observations of drills' procedural integrity

Each drill was conducted by the research team with the assistance of DPS and their school-based security officers (SSOs). Upon arriving at the school, the lead researcher met with the principal and the drill was initiated using a prewritten script.⁴ Drill calls were repeated to ensure that all building occupants heard the instructions and included the phrase “this is a drill” to ensure that everyone knew that it was practice and not a real-world scenario. Therefore, although the drills were not scheduled in advance with the schools, they were never unannounced, in accordance with best practices (National Association of School Psychologists [NASP] et al., 2021).

Accompanied by SSOs, research team members went room by room to check each for compliance on the four steps: doors locked, lights off, occupants out of sight and silent, and not answering door knocks. Responses for each criterion were recorded on a drill observation form,⁵ along with any other issues noted (e.g., people in the hallway, someone swiping in, teacher not having keys to lock the door). After knocking on the door (to simulate someone trying to gain entry), the research team entered the room to check if it was vacant, which also was recorded. If occupied, the research team advised participants that their room had been checked and reminded them to remain in lockdown until school administrators gave the “all clear.”

Once all rooms had been checked, the principal was notified and initiated the debrief period with an announcement over the PA system, which also is consistent with best practices (NASP et al., 2021). This time allowed participants to discuss the drill and ask questions of the research team. After two minutes, the drill was concluded, and regular activities resumed. Including the debrief period, drills took between 7 and 17 minutes, depending on the size of the school building.

Results

To determine whether skill mastery is maintained over time, we evaluated the procedural integrity across drills by assessing successful completion of each individual criterion. Vacant rooms were

dropped from the analyses, and the percentage of occupied rooms correctly completing each step was tabulated (e.g., if 48 out of 50 rooms had their lights off, 96% was entered as the criterion score). One-way ANOVAs were employed to compare the proportion of rooms successfully completing each criterion based on time. Scheffé's post-hoc analysis was included to determine when, if applicable, differences existed.⁶

Figure 1 presents the proportion of rooms correctly completing each individual step of the drill across all 10 drills. As illustrated, the proportion of doors that were locked districtwide began and remained high across all 10 drill periods, varying between 85% and 92%. The differences between these drills were not statistically significant ($F = 1.842$, n.s.). Conversely, significant improvement was found in the proportion of rooms correctly completing the step of getting the lights off ($F = 44.205$, $p < .001$). The post-hoc analysis reveals that, as compared to the first (pre-training) lockdown drill, each subsequent drills showed significant improvement in completing this step. Significant improvement also was demonstrated in the last two drills of Years 3 and 4, as compared to the post-training drill in Year 1.

We next examined the distribution of occupied rooms districtwide correctly getting occupants out of sight, meaning that they could not be seen or heard from the hallway. The results reflect significant improvement on this skill ($F = 57.947$, $p < .001$), with all post-training drills showing higher proportions of compliance compared to the pre-training drill. Additionally, each of the Year 3 and 4 drills was found to be significantly higher than the Year 1 post-training drill, with compliance on the out of sight measure also significantly higher in each of the Year 3 drills compared to the Year 2 drill.

The final criterion assessed as part of the lockdown drill is the proportion of rooms that responded to door knocks from the research team. During the first drill, more than one out of every three occupied rooms checked responded. Following training and for each drill thereafter, however, there was significant improvement on this measure ($F = 61.683$, $p < .001$). By the most recent drill, less than one percent of occupied rooms districtwide responded to the knocks.

To assess overall compliance, each occupied room was assigned a score between zero and four based on the number of correctly completed steps, with a score of four representing a perfect room check. The percentage of perfect checks by school were calculated and then aggregated to a districtwide measure. A one-way ANOVA with Scheffé's post-hoc analysis again was used to determine when,

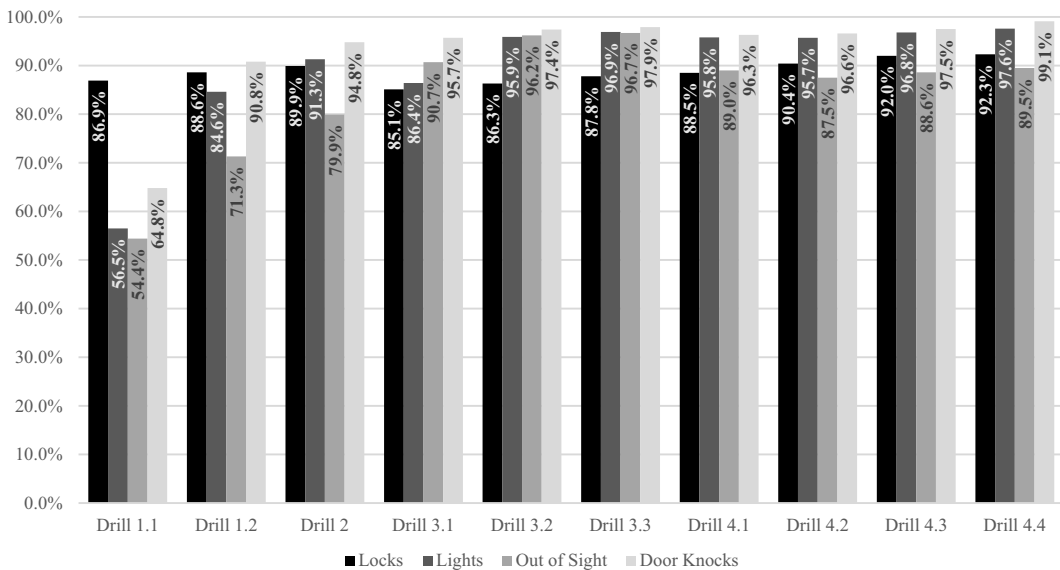


Figure 1. Distribution of Occupied Rooms Correctly Completing Individual Criteria, Districtwide

Locks: $F = 1.843$, n.s.; Lights: $F = 44.205$, $p < .001$; Out of Sight: $F = 57.947$, $p < .001$ Door Knocks: $F = 61.683$, $p < .001$

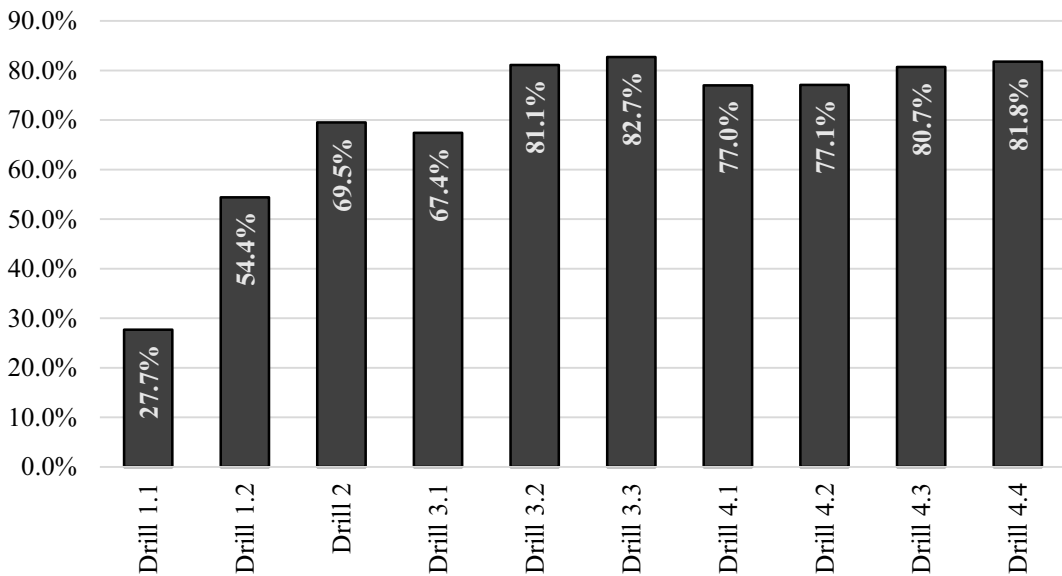


Figure 2. Distribution of Occupied Rooms with Perfect Checks, Districtwide
 $F = 50.278, p < .001$

if at all, there were significant differences in the measure. As illustrated in [Figure 2](#), the differences in proportions of perfect checks across time varied significantly ($F = 50.278, p < .001$). The post-hoc analysis revealed that compared to the initial pre-training drill, every subsequent drill reflected a significantly higher proportion of rooms successfully completing all four steps. Additionally, the latter two drills in the third year and all four drills in the fourth year each reflected significantly higher compliance compared to the post-training drill in Year 1.

Finally, we conducted a series of supplemental analyses examining the procedural integrity for each drill, based on the four individual criteria and percentage of perfect checks, based on building level. Due to space constraints, the results table is available in the online appendix (see Supplemental Table 1). The results largely mirror the aggregate findings. Specifically, there were no significant differences based on building level in the proportion of rooms with their doors locked. Conversely, significant improvement was found by building level for the lights, out of sight, door knock, and perfect check criteria. As with the districtwide assessment, the significant differences for each criterion reflected improvements across nearly every post-training drill as compared to the pre-training drill in the project.

In sum, the results indicate the following: (1) the proportion of locked doors began high and remained high across the duration of four years of lockdown drills; (2) significant improvement in the other three criteria – lights, out of sight, and door knocks – was found after the introduction of training; (3) this improvement was maintained across drills in the second, third, and fourth years of the project; and (4) the number of occupied rooms with perfect checks also increased significantly after the introduction of training and was similarly maintained for three additional years. These results and their implications are discussed in further detail later in the paper.

Study 2: Lockdowns in Real-World Events

Study 2 uses open-source data to investigate the protective efficacy of implemented lockdowns in real-world public mass shooting incidents. Notably, these data provide insight and implications for harm reduction, rather than incident prevention: all public mass shooting incidents included in Study 2 were

carried out with varying casualty outcomes. Two research questions are presented regarding the effects of lockdown procedures and security features at (1) schools-only mass shooting sites and (2) all public mass shooting sites.

Research Question 1 (RQ1): What are the effects of lockdown procedures and security features at school sites on casualty outcomes?

As noted, there is an absence of research examining the impact of these drills in real-world mass school shooting scenarios, yet there is no shortage of unsubstantiated claims made in the press and on social media regarding the utility of these drills. Therefore, it is crucial to consider the empirical relationship between lockdown procedures and casualty outcomes specifically in schools that experience a mass shooting incident. RQ1 aims to clarify the relationship between lockdown procedures implemented during mass school shootings and casualty outcomes. We hypothesized that lockdowns would exert a strong protective influence on different casualty outcomes at schools because they remove potential victims from the shooter's path.

Research Question 2 (RQ2): What are the effects of lockdown procedures and security features at all public mass shooting sites on casualty outcomes?

RQ2 broadens the examination from schools-only to all public mass shooting sites. While RQ1 is grounded in results from Study 1, RQ2 is exploratory because there currently is little to no data regarding the usage of lockdown drills and procedures in public locations (e.g., workplaces, malls, theaters, religious institutions). Furthermore, while some locations, like businesses and religious facilities, may implement lockdown drills as part of their formal institutional training, other public locations may initiate informal lockdowns in the event of a mass shooting, which could impact casualty outcomes. Therefore, RQ2 aims to broadly assess the impact of lockdowns on casualty outcomes during public mass shooting incidents to offer preliminary insight regarding use and efficacy of these procedures.

Methods

Definition

A public mass shooting was broadly defined as an incident of attempted or completed public gun violence perpetrated by at least one offender in a populated location, with behavioral indicators suggestive of mass intent. These indicators included bringing spare ammunition or firearms to the scene, leaking intent or discussing specific plans and threats, engaging in firearms training or stockpiling ammunition prior to the shooting, imitating past mass shooters through costuming or leakage, and aiming at or pursuing victims during the shooting. Together, these indicators suggest an offender seeking to kill multiple random or symbolic victims. Certain forms of mass public gun violence were excluded, in line with previous definitions (Krouse & Richardson, 2015; Schildkraut & Elsass, 2016), such as state-sponsored or police shootings, gang-related shootings, reactive violence (i.e., in response to a fight or altercation), residential shootings, and gun violence committed during the course of another crime (such as robbery).

Database establishment

The full database was established through review of 10 open-source datasets and listings of mass shootings, which covered a range of definitional criteria and years (Greene-Colozzi, 2022). Each case was reviewed for its alignment with the definition outlined above and was included if it met the basic criteria. A catchment-recatchment analysis was performed during database establishment to address selectivity bias in case inclusion (Chermak et al., 2012), which indicated a diminishing number of new cases with each sequential source reviewed. The final database consisted of 498 public mass shooting

incidents across 561 sites (accounting for spree shootings) between 1966 and 2019. Of these 561 sites, 93 (16.6%) were K-12 school sites, with the majority (59%) being high schools. The remaining sites included colleges, open public spaces (malls, restaurants, stores), workplaces, religious institutions, government facilities, and outdoor spaces.

Searching and coding

Three trained graduate students performed open-source searches to compile exhaustive case files on all incidents using 31 search engines (Greene-Colozzi, 2022). Each student searched every single case to gather all open-source material, including media reports, police reports and after-action reports, court documents, scholarly documents, social media, websites, and, whenever possible, pictures or videos related to the incident. The number of open sources per case ranged from 20 or fewer to over a thousand, depending on the incident's publicity. Approximately 45% of cases had either factual court documents or police documents in addition to media coverage. Once searching was completed, graduate students were trained by the principal investigator and randomly assigned cases to code using an inductive, theoretically derived codebook pertaining to situational crime prevention and an evidence-based coding procedure (Greene-Colozzi, 2022). Codebook variables were selected based on an extensive review of situational crime prevention literature (see, generally, Shariati & Guerette, 2017).

Predictor variables

The primary independent variable of interest was whether a lockdown of any kind was successfully implemented during the shooting (0 = No; 1 = Yes). The following additional variables related to security features were included as indicators of target "hardness" and also were coded dichotomously: whether any armed or unarmed security personnel were present during the shooting, if the site had CCTV cameras, if there was an enclosing fence or gate, and if there was some form of entrance control for gaining access, such as buzzer-controlled access, ID badges, or other personnel. The latter three variables – CCTV, gate, and entrance control – were combined into a scale index of Situational Crime Prevention (SCP) to account for their cumulative protective effects at the sites. Finally, the codebook included two types of resolution errors: errors in first response, such as police delays, 9-1-1 operator mistakes, and police failures, and errors in SCP implementation, such as failure to follow emergency alert or drill procedures, security guard errors and abandonment, and issues with place management and guardianship. Both error variables were measured dichotomously.

Outcome variables

Three count incident outcomes, measured continuously, served as dependent variables in inferential models: total casualties (injuries plus fatalities), number of victims pronounced dead at the scene, and total fatalities (on-scene deaths plus deaths in transit or at hospitals).

Missing data

As with all open-source data, missing variables were a significant measurement challenge. All cases were coded as completely as possible using available evidence, but certain predictor variables nevertheless retained some missingness. Rather than employ a "missing-as-no" practice (Parkin & Freilich, 2015), which has utility for certain types of data, we instead coded conservatively based on confirmatory evidence for "yes" codes and confirmatory evidence for "no" codes. If no confirmatory evidence was available, variables were coded as missing. To preserve sample size and address data missing-at-random,⁷ multiple stochastic imputation, specifically Multiple Imputation by Chained Equations (MICE; Royston, 2009; Rubin, 1987), was used to generate several complete datasets that were then combined for model estimation. MICE effectively reduced data loss for inferential models using both the full dataset of all public mass shooting sites and the dataset for schools-only sites. For more information on the MICE procedure, its utility in addressing data missing-at-random, and its appropriateness for the current data, see, Azur et al. (2011) and Greene-Colozzi (2022).

Data analysis

In addition to descriptive statistics, negative binomial regression modeling was used to assess multi-variable relationships and predict fluctuation in three incident outcomes: casualties, died at scene, and all incident fatalities. Since all three dependent variables are discrete counts and thus fail to meet the normal distribution assumption of OLS regression, negative binomial modeling was employed. Furthermore, the conditional variance exceeded the conditional mean for all three dependent variables, again indicating the superiority of negative binomial modeling over Poisson regression (Rydberg & Carkin, 2017). Negative binomial models were run on two separate datasets: a filtered dataset that had only K-12 school sites and the full dataset of all public mass shooting sites.

Results

Results are presented below and are separated according to schools-only data versus the full dataset of all public mass shooting sites. [Table 1](#) presents an overview of the incident outcomes. School sites saw an average of 6.0 total casualties, 2.0 fatalities, and 3.9 injuries. The mean number of victims pronounced dead on scene was 1.4. Slightly less than half of mass school shootings were mass casualty events (43%), defined as four or more total gunshot casualties. Few school shootings (13%) were mass death events, with four or more people killed.

The average casualty count at all public mass shooting sites was 6.7, with a mean of 2.9 fatalities and 4.0 injuries. An average of 2.2 victims were pronounced dead at the scene in all public mass shooting sites. Half of all public mass shootings were mass casualty events (52%) and about one-fifth (23%) were mass death events.

As illustrated in [Table 2](#), nearly half of school sites deployed lockdown procedures during the mass shooting incident. Security features, such as security personnel (32%), CCTV cameras (32%), and entrance control (27%) were moderately prevalent but not common. An enclosing fence or gate was

Table 1. Incident Outcomes

	Schools Only		All Sites	
	Mean/Percent*	SD/N*	Mean/Percent*	SD/N*
Total Casualties	6.0	8.0	6.7	21.5
Fatalities	2.0	3.8	2.9	4.2
Injuries	3.9	5.4	4.0	18.1
Died at Scene	1.4	3.4	2.2	3.8
Mass Casualty	43.0*	40*	51.5*	289
Mass Death	12.9*	12*	22.5*	126
N	93		561	

Bolded items are outcomes used in regression models

* Indicates Percent/N

Table 2. Security Features

	Schools Only			All Sites		
	Percent	N	% Missing	Percent	N	% Missing
Lockdown	48.4	45	11.8	19.1	107	9.5
Any Security	32.3	30	23.6	24.1	135	22.9
Armed Security	22.6	21	–	11.2	63	–
Unarmed Security	9.7	9	–	12.8	72	–
SCP Error	21.5	20	11.8	16.6	93	7.1
First Responder Error	6.2	3	9.7	8.6	48	6.6
CCTV	32.3	30	46.2	26.9	151	45.9
Fence/Gate	18.3	17	12.9	12.1	68	12.3
Entrance Control	26.9	25	39.8	22.9	151	21.9
N	93			561		

relatively infrequent at school sites (18%). While substantial first responder error was uncommon at school sites (6%), errors in SCP implementation were more frequent (22%).

Lockdown procedures were less common at all public mass shooting sites (19%). Security personnel (24%), CCTV cameras (26%), and entrance control (23%) had similar prevalence at all sites as at school sites. An enclosing fence or gate was uncommon at all sites (12%). Errors in first response remained rare (9%), as did errors in SCP implementation (17%).

Research Question 1: Effect of Lockdowns at School Sites

Model 1 in Table 3 displays a protective influence of lockdowns on total casualties in the presence of other variables. Schools that successfully implement a lockdown during a mass shooting experience 59% fewer total casualties. This effect is retained while controlling for other influential variables, including implementation error. Model 2 incorporates the effect of first responder error, most notably, delays in arrival or entry. First responder error is significantly harmful in the event of a school mass shooting. Further, the inclusion of this variable in the model renders the protective influence of lockdowns non-significant.

These findings hold when considering different outcomes, as presented in our online supplemental analyses. First, lockdowns reduce the number of victims pronounced dead at the scene by 79%, while controlling for the harmful effects of SCP error (see Supplemental Table 2, Model 1). The protective impact of lockdowns, however, is no longer significant when first responder error is introduced (Model 2). The same effect occurs when estimating the predictors of total fatalities (not just those pronounced dead at the scene; see Supplemental Table 3). Here, lockdowns exert a protective influence on incident outcome, reducing fatalities by 63%, until we control for first responder errors. The harm done by first responder errors has a critical effect on incident outcomes, possibly weakening the life-saving influence of lockdowns.

Research Question 2: Effect of Lockdowns on All Public Mass Shooting Sites

Consistent with the schools-only models, lockdowns exert a strong, protective influence on total casualties in the total sample of public mass shooting sites (Table 4). This remains significant even after controlling for first responder errors. At sites of public mass shootings overall, lockdowns are correlated with reductions in number of casualties (36–38%), on-scene deaths (35–39%; see Supplemental Table 4), and total fatalities (32–35%; see Supplemental Table 5), even when police error or human error in SCP implementation occur. Lockdowns remain protective even in the presence of first responder error, unlike in the schools-only models. This suggests that school sites are uniquely vulnerable to first responder errors.

Table 3. Negative Binomial Regression on Casualties at School Sites

<i>Casualties</i>	Model 1				Model 2			
	IRR	Std. Error	95% CI		IRR	Std. Error	95% CI	
Lockdown	0.411**	0.129	0.222	0.760	0.666	0.234	0.334	1.328
SCP	1.211	0.226	0.839	1.747	0.958	0.183	0.658	1.393
Any Security	1.193	0.353	0.668	2.132	0.891	0.272	0.491	1.617
SCP Error	1.815*	0.542	1.010	3.259	1.592	0.450	0.915	2.771
First Responder Error	–	–	–	–	4.072*	2.127	1.462	11.337
Constant	7.806***	1.702	5.092	11.968	6.019***	1.312	3.926	9.228

Imputations = 35
 Observations = 83
 Chi-square = 2.38*

Imputations = 35
 Observations = 83
 Chi-square = 3.19**

*p < .05; **p < .01; ***p < .001

Table 4. Negative binomial regression on casualties at all sites

<i>Casualties</i>	Model 1				Model 2				
	IRR	Std. Error	95% CI		IRR	Std. Error	95% CI		
Lockdown	0.635**	0.092	0.487	0.842	0.618**	0.087	0.469	0.813	
SCP	0.683	0.067	0.845	1.109	0.972	0.066	0.850	1.111	
Any Security	1.734***	0.207	1.372	2.193	1.696***	0.197	1.350	2.130	
SCP Error	1.263	0.179	0.956	1.669	1.049	0.153	0.789	1.397	
First Responder Error	–	–	–	–	1.939***	0.339	1.376	2.732	
Constant	6.026***	0.388	5.312	6.836	5.839***	0.373	5.153	6.617	
Imputations = 18					Imputations = 18				
Observations = 522					Observations = 522				
Chi-square = 7.60***					Chi-square = 9.09***				

* $p < .05$; ** $p < .01$; *** $p < .001$

There also is an intriguing harmful effect of security presence on total casualties (Table 4) not retained on victims pronounced dead at the scene or total fatalities. The presence of security personnel, which includes both unarmed and armed guards, increases total casualties by 70–73%, depending on the additional variables in the model. This may be because unarmed security guards are more likely to become victims themselves when confronted with a mass shooter. Supplemental Table 6 re-estimates these models with security disaggregated (unarmed versus armed). While the effects of lockdowns remain consistent, both armed and unarmed security increase casualties as compared to no security presence. Unarmed security exerts the strongest harmful effect.

Discussion

This two-part study adds important empirical research to the debate about lockdown drills regarding their purpose and effectiveness. More specifically, the results indicate that lockdown drills, particularly when paired with training, lead to significant improvements in the procedural integrity of implementing the steps of this harm mitigation practice (i.e., doors locked, lights off, occupants out of sight and silent, no response to door knock) in K-12 schools. Additionally, analyses of real-world mass shootings in schools and other public spaces indicate that among multiple possible harm reduction strategies, lockdowns were the most consistent and significant protective factor in reducing casualties.

Do lockdown drills and training lead to sustained improvement in skill mastery?

In Study 1, we find that participating in lockdown drills and training lead to significant improvements in students' and school staff members' skill mastery over a prolonged period. Although door locks were implemented consistently, the other three steps of the procedure showed significant improvements from before training (Drill 1.1) to after it (Drill 1.2). Mastery of the steps of lights off, out of sight, and not responding to door knocks improved 28%, 17%, and 26%, respectively. Perfect checks also nearly doubled, increasing about 27% between the two drills. These results are consistent with other studies finding improvements in procedural integrity of drills when paired with instruction on the practice (Dickson & Vargo, 2017; Schildkraut & Nickerson, 2020; Zhe & Nickerson, 2007).

Unlike previous studies that were conducted within short periods of time (i.e., less than six months), a strength of the current study is that data were collected at 10 independent time points over a four-year period. Despite potential concerns about ongoing drilling leading to complacency or possible declines in performance, data from the current study indicate that each step of the lockdown drill was performed better in the most recent practice as compared to the drill prior to training (improvements of approximately 5% [locks], 41% [lights], 35% [out of sight/quiet], 34% [door knocks], and 54% [perfect checks]).

Perhaps most notable is that the improvements gained in the drill immediately after the training were sustained over each of the subsequent eight practices. This suggests that drilling can, indeed, achieve the goal of building muscle memory (Shusterman, 2011) and that consistent practice helps to maintain this development over time. Moreover, consistent training and practice allow schools to identify areas needing improvement, implement strategies (e.g., retraining either completely or on one specific step) to remedy the issue, and reassess in subsequent drills to determine if the issue is resolved. This may include more challenging aspects, such as staying out of sight and remaining quiet (Dickson & Vargo, 2017; Schildkraut & Nickerson, 2020), which showed an almost 20% improvement from after the first training to the most recent drill.

Do lockdowns save lives in real-world mass shootings?

Study 2's findings suggest compelling support for lockdowns being an effective harm mitigation strategy in real-world events. During mass shootings, schools that successfully implemented lockdowns had 60% fewer total casualties, with 79% reductions in victims pronounced dead at the scene even after controlling for other variables (e.g., presence of security, access control, implementation error). When first responder error (e.g., delays in arrival or entry) was added to the model, lockdowns were no longer significant in reducing the number of casualties or deaths. Although lockdowns were implemented less often in other public places compared to schools, their use was associated with protective effects against total casualties and total fatalities (32–38% reduction), with 35–39% decreases in on-scene deaths. Importantly, these reductions were significant even when first responder error and other control variables were included. These results are consistent with findings from commissions after high-profile school shootings indicating that locked doors are a successful lifesaving device (Columbine Review Commission, 2001; Sandy Hook Advisory Commission, 2015), but extends this work beyond a single incident to include an empirical analysis of 93 school sites, as well as 561 public mass shooting sites.

Our research focused on lockdowns specifically, but the other potential protection strategies also are important to consider. There was an unexpected finding that the presence of security personnel (unarmed and armed guards) increased total casualties by 69–73% at all public mass shootings sites. Having security guards may be a mitigation strategy employed in more high-risk contexts (e.g., where there are large gatherings of people or where crime is more likely), so it is possible that this finding reflects other aspects of the incident. It also is possible that security guards are more likely to become victims themselves when confronted with a mass shooter, which was the case in both the Red Lake High School shooting (Red Lake, MN) in 2005 (Enger, 2015) and the Tops Supermarket attack (Buffalo, NY) in 2022 (Becket, 2022), or that their mere presence increases hostility and aggression from the perpetrator (Bushman, 2013). Notably, though, this effect of security presence was not seen at school sites. Security had no significant impact on any outcomes in mass school shootings.

It also is critical to highlight that the protective influence of lockdowns in mass shootings at school sites actually was negated when first responder errors were included in the model. These errors, which most commonly were delayed arrival or entry, may negate the effects of lockdowns in several ways. Deaths on scene may increase because injured victims risk bleeding out if they do not receive immediate care. Perpetrators also may have more time to search for victims, reveal or invade hiding spaces, or find people who may not have been able to initiate lockdown, which can increase total casualties.

Recommendations from many of the commissions on school shootings emphasize the need for law enforcement officers and other first responders to deploy and respond rapidly (Columbine Review Commission, 2001; Sandy Hook Advisory Commission, 2015). For example, during the shooting in Uvalde, although law enforcement was on scene nearly immediately and they entered the building less than three minutes after the perpetrator did, they failed to breach the impacted rooms for more than 71 minutes (Advanced Law Enforcement Rapid Response Training [ALERRT], 2022). Children in the classrooms where the shooting occurred placed multiple calls to 9-1-1 over that duration, advising that

people were injured, but police held in the hallway. As noted by ALERRT (2022), “[w]hile we do not have definitive information at this point, it is possible that some of the people who died during this event could have been saved if they had received more rapid medical care” (p. 19). This finding emphasizes the point that lockdowns are one part of larger comprehensive school efforts (e.g., effective preparedness and collaboration with multiple agencies, use of Incident Command System [ICS]; Schildkraut & Nickerson, 2022).

Implications for policy and practice

There are several ways in which results from this study should inform policy and practice. First, it is essential to report clearly and precisely about the purpose, best practices for, and impact of lockdown drills in the public discourse. The key messages should be that lockdowns: (a) are a harm mitigation practice (not a prevention strategy) designed to save lives in the event that a danger occurs within a school building (Schildkraut & Nickerson, 2022), (b) include procedural steps of locking doors, turning out lights, remaining out of sight and quiet, and not responding to door knocks (or anything else – e.g., fire alarm unless released by law enforcement or designated authority; Keyes & Deffner, 2015), (c) have been shown by research to lead to skill attainment across K-12 students in the short-term (Dickson & Vargo, 2017; Schildkraut & Nickerson, 2020; Zhe & Nickerson, 2007) and over multiple years (current study), and (d) are a consistent protective life-saving strategy in real-world mass shootings (Columbine Review Commission, 2001; Sandy Hook Advisory Commission, 2015; current study).

Second, and following from the points above, is that there should be a national standard and consistent protocols for lockdowns to standardize the procedure for those experiencing the crisis and for first responders arriving on scene to assist (NASP et al., 2021; Schildkraut & Nickerson, 2022). Currently, states, districts, and individual schools have wide variability in these practices. There also is confusion among the public, the media, and other groups about the practice and purpose of lockdowns, often stemming from conflating these with active shooter or armed assailant drills, some of which include multiple options not part of the standard lockdown procedure (NASP, 2020). National standards and consistent implementation are critical for clarity among those involved in incidents directly and indirectly.

Third, lockdown drills are an important part of comprehensive school safety preparedness. In order to be most effective, they must be employed by a collaborative, multidisciplinary safety team that operates according to the National Incident Management System’s ICS (U.S. Department of Homeland Security, 2008), that has planned for multiple threats and hazards across settings and times (e.g., events on and off campus, such as sporting events; before, during, and after school), and that provides for access and functional needs of the entire school community (Brock et al., 2016). An essential part of the ICS and comprehensive school safety is collaboration with first responders and other agencies (U.S. Department of Education, 2013). Indeed, the results of Study 2 underscore how the protective effects of lockdowns also can be dependent on the actions of first responders. This relates to the purpose of lockdowns – to mitigate harm in the event of a danger – as opposed to replacing prevention or policy that protects people from mass violence.

Limitations and future research directions

Despite the advances made by this two-pronged study, each has its limitations as well. Study 1 was conducted in one urban school district with a specific response protocol (SRP-X; Keyes & Deffner, 2015). Additional research should include other schools and locations (e.g., rural and suburban areas). Studies also should compare a standardized lockdown procedure to other approaches, such as options-based protocols, as the conclusions from this study apply to lockdowns adhering to a specific response protocol. Study 1 was conducted with the same schools across 10 time points over four years, although the data were not experimental (e.g., there was no randomized control group) and the samples were

not matched across the timepoints. Although there were marked improvements over time in skill attainment, we cannot conclude with certainty that the drills and training led directly to these changes for specific individuals. Future research should employ randomized controlled trials, possibly using a wait-list control condition since drills are required and it would be unethical to withhold these. Further, although largely not supported by existing scholarship (e.g., Nickerson & Schildkraut, 2021; Schildkraut & Nickerson, 2022), concerns have been raised about the potentially traumatic effects of lockdown drill participation (Rygg, 2015). Accordingly, future research should assess the procedural integrity in conjunction with various potential psychological outcomes, including perceived safety and preparedness, anxiety, fear of harm, and other metrics, to better understand how such impacts may be affected by the way the drill was conducted (i.e., in accordance with best practices; see, Schildkraut & Nickerson, 2022).

Study 2 used open-source data, allowing for a comprehensive examination of multiple events, although there also are limitations in this approach. Selectivity bias from time and media effects remains a common challenge in open-source universe establishment, especially for databases with broad definitions of mass shootings and lengthy timelines. Catchment-recatchment (Chermak et al., 2012) is one technique to address this limitation and ensure that the open-source universe is indeed capturing the majority of eligible cases. Additionally, missing data are a well-known limitation for open-source studies. Fortunately, transparent reporting of missingness, as well as imputation strategies, can preserve the integrity of the sample and data. It also is worth noting that the sample of 93 schools is relatively small for inferential models. This is a somewhat unavoidable challenge with rare-event research, such as mass school shootings, but nevertheless merits acknowledgment. Finally, because of the small sample size in the schools-only analyses, some predictor variables had extremely low counts. In particular, first responder errors in schools occurred at fewer than 10% of sites. Effects of this low count can be observed in regression models showing inflated standard errors and large confidence intervals for this variable.

Finally, lockdowns serve as one important response avenue for harm mitigation in the event of a mass or school shooting. Research should continue to examine preventative techniques, in addition to harm mitigation strategies, to address these incidents' occurrences. In combination with lockdown drills, preventive measures like a multi-tiered system of support (Cornell, 2020) or positive behavioral intervention and supports (Bradshaw et al., 2010) may help to reduce incidence as well as harm.

Conclusion

In light of public debate and misunderstanding about preparedness practices in the event of mass violence, particularly school shootings, it is critical to have empirical evidence about practices such as lockdowns. This two-part study adds unique dimensions to the scholarship on lockdown drills by assessing the implementation and skill mastery over multiple years and examining lockdown practices in relation to casualties in mass shootings in public spaces and schools more specifically. Lockdown drills and training led to significant improvements in skill mastery over multiple years. Furthermore, lockdowns were helpful in mitigating harm in real-world mass shooting events, although results varied depending on the actions and errors of first responders in the school incidents. Findings from this study should be used to better inform policymakers and the general public about the purpose and effectiveness of these practices and to advocate for national standards for lockdown drills.

Notes

1. The breakdown of the school buildings is as follows: 14 elementary schools, 5 combined Pre-K to 8 schools, 6 middle schools, and 5 high schools. Per State Education data (<https://data.nysed.gov>), 49% of the district's students identify as Black or African American, 22% as White, 14% as Hispanic or Latino, with the remaining 15% encompassing other races. Further, 18% are English language learners and 81% are economically disadvantaged.

2. See New York State Education Law, Title 1, Article 17 § 807.
3. All schools participated in both drills of Year 1. Six schools did not have drills in Year 2 due to the transition to online learning during COVID, while another remained fully online in Year 3 and did not participate in in-person drills. In Year 4, one school did not participate in the two fall drills due to construction that limited building access, while another's first drill was stopped before it concluded and was not recorded.
4. For the first drill in Year 1, the drill call was "This is a lockdown. This is a drill." For the second drill (post-training) and each drill thereafter, the drill call was made using the language from the protocol trained: "Lockdown! Locks, lights, out of sight! This is a drill."
5. Each member of the research team was trained on how to complete the drill observation form. The SSOs also had walkie-talkies, which could be used to contact the PI during the drill with any questions.
6. All post-hoc analysis results for Study 1 are presented in Supplemental Table 1 online.
7. Little's MCAR test for the schools-only dataset indicates data are Missing Completely at Random (MCAR) or Missing at Random (MAR) ($\chi^2 = 102.9$; $p = 0.068$). Little's MCAR test for the full dataset similarly indicates data are MCAR or MAR ($\chi^2 = 190.8$; $p = 0.311$). Data are treated as MAR for multiple imputation with case reliability as a predictive covariate of missingness.

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