

# Epidemiology and clinical aspects of stray bullet shootings in the United States

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<b>BACKGROUND:</b>	Stray bullet shootings contribute to a sense of risk in affected communities but have rarely been studied. We describe the epidemiology and clinical aspects of stray bullet shootings in the United States.
<b>METHODS:</b>	We defined a case as a shooting event involving death or injury to a person and meeting criteria for a stray bullet mechanism of injury. From March 1, 2008, to February 28, 2009, we conducted real-time surveillance using two automated Internet news searches for the term “stray bullet.” Secondary searches were performed to identify new cases and additional news reports.
<b>RESULTS:</b>	We reviewed 1,996 nonduplicate news reports for 501 shooting events, of which 284 (56.7%) met our case criteria. There were 317 persons injured by stray bullets, of whom 65 (20.5%) died. Most cases (59.2%) involved interpersonal violence. When compared with persons killed or injured in firearm-related assaults or unintentional shootings generally in the United States in 2007, those killed or injured by stray bullets were more likely to be female (44.8% and 10.7%, respectively; odds ratio, 7.4; 95% confidence interval, 5.9–9.3) and outside the age range 15 years to 34 years (55.5% and 27.0%, respectively; odds ratio, 5.6; 95% confidence interval, 4.3–7.3). Most stray bullet victims (81.4%) were apparently unaware of the events leading to the gunfire that caused their injuries. Shooters were predominantly male (95.9%); 62.0% were aged 15 years to 34 years. Eighteen deaths (27.7%) occurred at the scene of the shooting and 55 (84.6%) on the day of the shooting. The case-fatality ratio for stray bullet shootings was somewhat higher than that for firearm-related assaults or unintentional shootings in the United States in 2007.
<b>CONCLUSION:</b>	Stray bullet shootings are epidemiologically distinct from other firearm-related injury events. It is likely that not all stray bullet shootings were identified, there may have been differential reporting related to severity of outcome, and missing data were common. ( <i>J Trauma Acute Care Surg.</i> 2012;73: 215–223. Copyright © 2012 by Lippincott Williams & Wilkins)
<b>LEVEL OF EVIDENCE:</b>	Epidemiological study, level III.
<b>KEY WORDS:</b>	Violence; firearms; wounds; gunshot; stray bullet; surveillance.

On January 10, 2008, as 10-year-old Christopher Rodriguez sat for his piano lesson at the Harmony Road Music School in Oakland, CA, a robbery took place at the gas station across the street. The perpetrator fired three gunshots. One bullet went through the wall of the music school and struck Christopher, traversing his spleen, kidney, and spine. Eighteen months later, the perpetrator was sentenced to 70 years to life in prison. Christopher attended that hearing in his wheelchair, shook his assailant's hand, and told him, “I forgive you.” His mother told a reporter that Christopher, a basketball player and skateboarder, did not dream of walking again, but only of running: “He’s a kid.”<sup>1,2</sup>

Stray bullet shootings contribute to a sense of insecurity and fear in affected communities.<sup>3–9</sup> Children may be sent to stay with friends or relatives in lower risk neighborhoods after school and may be required to remain indoors after dark (and during the day, unless with an adult). They are taught to avoid crowds and people talking loudly, run when they see weapons, drop to the ground when they hear gunfire while outside, and take cover away from windows if indoors—in the bathtub, if possible.<sup>3–6,10</sup> Adults become hypervigilant. They, too, stay indoors, during the day and at night.<sup>5,11</sup> They may run errands in the morning or on weekends, when gunfire is less common.<sup>6,7,12</sup> The Centers for Disease Control and Prevention (CDC) has advised entire communities to remain indoors at times of particular risk.<sup>13</sup>

There is little systematic information about stray bullet shootings and, excepting a preliminary report of this study,<sup>14</sup> none that is recent. Sherman et al.<sup>15</sup> used newspaper indexes to identify 37 fatal and 88 nonfatal “random shootings of bystanders” in New York City; Los Angeles; Washington, DC; and Boston during 1977 to 1988. CDC found 1 death and 18 other injuries in Puerto Rico from bullets fired into the air during the 2003 to 2004 New Year's holiday.<sup>13</sup> Investigators at a South Los Angeles hospital described 118 persons injured by “spent” bullets from 1985 to 1992; most (77%) were struck in the head, and the case-fatality ratio was 32%.<sup>16</sup> In Detroit in 2002, 8 of 25 homicides among persons younger

Submitted: September 12, 2011, Revised: January 13, 2012, Accepted: January 20, 2012.

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Supported, in part, by grants from The California Wellness Foundation and The Eli and Edythe L. Broad Foundation.

A preliminary report of these findings appeared as Wintemute GJ, Claire B, McHenry V, Wright MA. Stray bullet shootings in the United States [Research Letter]. *JAMA.* 2011;306:491–492.

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DOI: 10.1097/TA.0b013e31824c3abc

*J Trauma Acute Care Surg*  
Volume 73, Number 1

215

than 17 years involved bystanders to violent confrontations.<sup>17</sup> In Cook County, IL, during 1984 to 1992, 14 stray bullet deaths accounted for 45% of all firearm homicides among children aged 10 years or younger.<sup>18</sup> Other recent reports have presented individual cases<sup>19–24</sup> or small case series.<sup>25,26</sup>

Shortly after the California shooting reported above, and given the lack of existing data, we began surveillance for stray bullet shootings in the United States. We report here our findings for 284 shooting events occurring between March 1, 2008, and February 28, 2009.

## MATERIALS AND METHODS

### Case Definition

We defined a case as a shooting event involving death or injury to a person and meeting criteria for a stray bullet mechanism of injury. We excluded shootings of animals or objects and near misses of people. We did not require that the injury be a gunshot wound and included events in which persons were injured by secondary mechanisms, such as by glass sent flying when a stray bullet struck a window.

“Stray” has been used as an adjective since at least the 17th century, describing a person or thing that is “separated from the main body; occurring away from the regular course or habitat; isolated.”<sup>27</sup> We defined a stray bullet as one that had escaped the sociogeographic space or perimeter customarily set by the circumstances surrounding the firing of the gun from which it came. “Space or perimeter” could be primarily geographic: measured by simple distance, for example, or by such specifics as the bounds of a shooting range or the trajectory joining a hunter with his prey. Alternatively, the terms could be defined socially, such as to include active participants in acts of violence and their targets.

The person killed or injured could not be an intended target of the shooter. Thus, we did not include events in which persons were shot intentionally after being targeted at random or those involving intentional but collective targets, such as a group of teenagers at a party. Nor did we include shootings in which the shooter deliberately pointed a gun at an individual but did not intend to fire the gun.

We included shootings of persons identified as bystanders only if there was no suggestion that they played an active role in the events leading to their injuries or were targeted intentionally. We included events in which persons were injured when shooters targeted structures, either unaware of or disregarding the fact that the structures were inhabited. Shootings involving ricochet bullets were included if the victim would have been classified as struck by a stray bullet had no ricochet been involved. We also included shootings that occurred when the firing of the gun was unintentional and no person had been targeted, such as while performing gun maintenance or cleaning, except when the shooter and victim were the same person.

Finally, we included shootings resulting from bullets fired into the air, commonly during holidays, a practice known as celebratory gunfire.<sup>13</sup> We reasoned that the space customarily defined by the circumstances of such shooting does not extend to the object the bullet will strike on its return

to earth. Shootings meeting the case definition were included if they occurred in the United States between March 1, 2008, and February 28, 2009.

### Case Identification and Data Acquisition

We identified potential cases primarily by contemporaneous passive surveillance, using the automated Google and Yahoo! news alert services, which capture reports from both print and broadcast media outlets, and the search term “stray bullet.” Google News monitors ~4,500 English language news sites on the Internet; comparable data for Yahoo! could not be located.<sup>28,29</sup> We used a contemporaneous rather than a retrospective design to maximize our ability to retrieve articles that had generated news alerts. We identified additional potential cases by active surveillance, reviewing the text of retrieved articles and searching the archives of the proprietary news service GunPolicy.org using the terms “stray bullet” and “celebratory.”<sup>30</sup>

Beginning a year after our enrollment period ended, we conducted secondary searches on all cases to identify further initial reports and any follow-up reports. These searches concentrated on, but were not limited to, the media sources that had reported on the shootings when they occurred and other sources in those communities. Searches were done on the term “stray bullet” and separately on the names of any identified persons involved.

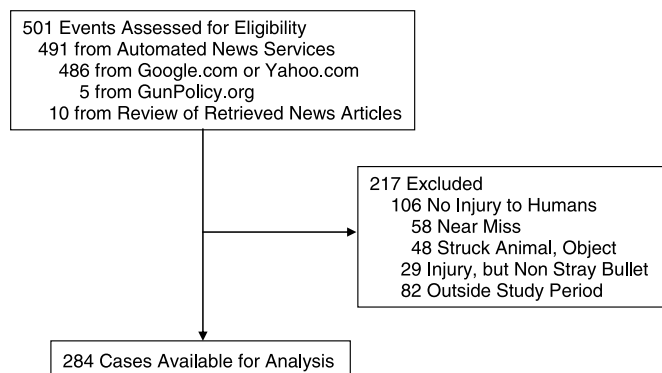
We did not retrieve articles for which payment or a subscription was required (<5% of articles). A few articles identified in secondary searches had apparently not been archived at the source’s Web site and could not be retrieved (~2% of articles).

We obtained national mortality and injury data from CDC’s Web-Based Injury Statistics Query and Reporting System (WISQARS) databases. These databases provide fatal injury data based on death certificates in the National Vital Statistics System and nonfatal injury data based on reports from a nationally representative sample of hospital emergency departments to the National Electronic Injury Surveillance System—All Injury Program.<sup>31</sup>

### Data Abstracting

Three authors working independently abstracted articles for an initial panel of cases to refine abstracting rules and identify potential sources of error in interpretation. All authors participated in formulating final rules. Thereafter, articles for each case were abstracted by one of the authors, whose work was reviewed by at least one other. Differences were resolved by consensus.

We abstracted data for key characteristics of the cases and of all shooters, victims, and weapons. (Cases that were incidental to violence could involve several persons killed or injured, not all by stray bullets; several shooters; and several weapons.) Narrative histories were prepared. We reviewed follow-up articles for information on long-term outcomes. When there were discrepancies, we gave preference to the information more commonly or most recently reported. Dual data entry was performed.



**Figure 1.** Process of case identification. Reprinted with permission from *JAMA*. 2011;306:491–492. Copyright © 2011 American Medical Association. All rights reserved.

### Data Analysis

We used “nonstray bullet” to describe a bullet that struck an apparently intended human target. Fetuses that died as a result of fatal gunshot wounds to pregnant women, and two infants who died after delivery at a previsible gestational age by a woman who had been shot but survived, were coded as having died from gunshot wounds. We defined three holiday periods: Cinco de Mayo, May 4 to 6; 4th of July, July 4 to 6; New Year’s Eve, December 30 to January 1. Proportions were calculated based on all cases identified. Our main analysis used standard descriptive measures.

We compared the age and sex distributions of stray bullet victims to those of all persons shot and killed or injured in the United States in 2007 (the most recent year available) as a result of interpersonal violence (homicide and assault) or an unintentional shooting. The age comparison was based on age inside or outside the range 15 years to 34 years, the age during which risk for an assault-related or unintentional gunshot wound is highest in the general population.<sup>31</sup> This comparison was made using odds ratios (ORs) with 95% confidence intervals (CIs).

To assess for reporting bias based on injury severity, we compared the separate case-fatality ratios for persons injured by stray bullets and nonstray bullets in cases arising from interpersonal violence with the case-fatality ratio for firearm-related homicide and assault in the United States in 2007. Our hypothesis here was that if reporting of stray bullet shootings were related to severity of outcome, we would find higher case-fatality ratios in our case data. This comparison was made based on the absolute difference in the case-fatality ratios, which were expressed as proportions. We also determined whether severity of outcome and victim age and sex were associated with the number of news articles identified, comparing medians using the Wilcoxon rank sum test.

Data were analyzed using SAS version 9.1.3 for Windows<sup>32</sup> and VassarStats.<sup>33</sup> Throughout,  $p < 0.05$  in a two-tailed test was taken as the level of statistical significance.

### Approval

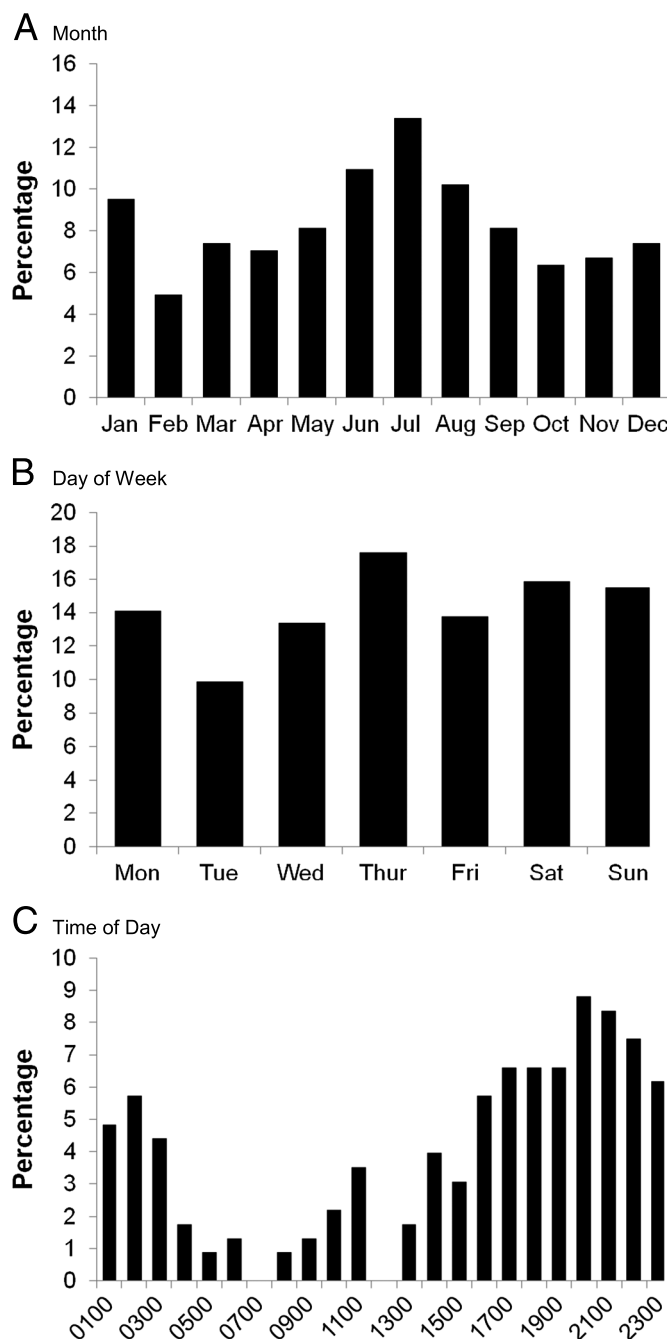
The Institutional Review Board of the University of California, Davis Health System, determined that this project was exempt from review.

## RESULTS

We reviewed 1,996 nonduplicate news reports for 501 shooting events in the United States, of which 284 (56.7%) met our case criteria (Fig. 1; the Appendix provides summaries of selected cases).

### Event Characteristics

Shootings occurred in 41 states and were concentrated in urban areas with 139 (48.9%) occurring in 48 cities having



**Figure 2.** Percentage of stray bullet shootings by month, day of week, and time of day. (A) month, (B) day of week, (C) time of day.

**TABLE 1.** Characteristics of Stray Bullet Shootings, Victims, and Shooters

Characteristic	N (%)
Circumstances of event	
Incidental to violence	168 (59.2)
Hunting, other sports	21 (7.4)
Celebratory	13 (4.6)
Maintenance, handling	8 (2.8)
Other	9 (3.2)
Unknown	65 (22.9)
Stray bullet shooter's location	
Shooter's residence	7 (2.5)
Other residence	55 (19.4)
Store/business	11 (3.9)
Restaurant/bar	7 (2.5)
Street, sidewalk, alley	60 (21.1)
Other public place	34 (12.0)
Vehicle	26 (9.2)
Other	6 (2.1)
Unknown	78 (27.5)
Stray bullet victim's location	
Victim's residence	129 (40.7)
Other residence	49 (15.5)
Store/business	9 (2.8)
Restaurant/bar	16 (5.1)
Street, sidewalk, alley	41 (12.9)
Other public place	34 (10.7)
Vehicle	29 (9.2)
Other	0 (0.0)
Unknown	10 (3.2)
Stray bullet victim demographics	
Sex	
Male	159 (50.2)
Female	142 (44.8)
Unknown	16 (5.1)
Age (yr)	
0–4	27 (8.5)
5–14	72 (22.7)
15–24	53 (16.7)
25–34	32 (10.1)
35–44	23 (7.3)
45–54	19 (6.0)
55–64	18 (5.7)
Older than 65	17 (5.4)
Unknown	56 (17.7)
Stray bullet gunshot wound location	
Extremity	106 (35.0)
Torso	91 (30.0)
Head, face, neck	62 (20.5)
Unknown	44 (14.5)
Nonstray bullet victim demographics	
Sex	
Male	46 (86.8)
Female	5 (9.4)
Unknown	2 (3.8)

**TABLE 1.** (Continued)

Characteristic	N (%)
Age (yr)	
0–4	0 (0.0)
5–14	0 (0.0)
15–24	30 (56.6)
25–34	10 (18.9)
35–44	2 (3.8)
45–54	3 (5.7)
55–64	0 (0.0)
Older than 65	0 (0.0)
Unknown	8 (15.1)
Stray bullet shooter demographics	
Sex	
Male	94 (95.9)
Female	2 (2.0)
Unknown	2 (2.0)
Age (yr)	
0–4	0 (0.0)
5–14	5 (5.1)
15–24	48 (49.0)
25–34	11 (11.2)
35–44	4 (4.2)
45–54	8 (8.2)
55–64	0 (0.0)
Older than 65	0 (0.0)
Unknown	22 (22.5)

populations of 250,000 or more. They occurred most frequently during the summer, were not more common on the weekend than during the week, and were clustered between 4:00 pm and 3:00 am (Fig. 2). Only 17 shootings (6.0%) occurred during the Cinco de Mayo, 4th of July, or New Year's holidays.

Seven shootings (2.5%) were known to result from the unintended firing of a gun. Other selected characteristics of the shootings are presented in Table 1. Shootings were incidental to interpersonal violence in 168 cases (59.2%). A plurality of stray bullet shooters fired their guns from a street, sidewalk, or alley (21.1%).

### Victim Characteristics

Altogether, 370 persons were killed or injured. There were 317 persons (85.7%) killed or injured by stray bullets, 303 (81.9%) receiving stray bullet gunshot wounds and 14 (3.8%) injured by secondary mechanisms. Nonstray bullets killed or injured another 53 persons (14.3%).

Of stray bullet victims overall, 142 (44.8%) were female and 176 (55.5%) were outside the age range 15 years to 34 years; 99 (31.2%) were children aged 0 year to 14 years (Table 1). Females were more common among persons killed or injured by stray bullets than among persons killed or injured in firearm-related assaults or unintentional shootings nationwide in 2007 (8,342 of 77,639 [10.7%]; OR, 7.3; 95% CI, 5.9–9.3). Similarly, persons outside the age range 15 years to 34 years were more common among those killed or injured by stray bullets

than among those killed or injured in firearm-related assaults or unintentional shootings nationwide (20,846 of 77,315 [27.0%]; OR, 5.6; 95% CI, 4.3–7.3).

Most stray bullet victims (258, 81.4%) seemed to have been completely unaware of the events leading to the gunfire that caused their injuries. A plurality (129, 40.7%) were at home (Table 1) and most of this group (88, 68.2%) were indoors.

Sixty-five stray bullet victims died, for a case-fatality ratio of 20.5%. None of those who died had been injured by a secondary mechanism. Death occurred at the scene of the shooting in 18 fatalities (27.7%) and on the same day as the shooting in 55 (84.6%). Case-fatality ratios specific to wound location for stray bullet gunshot wounds were 0% for extremity wounds; 28.6% for wounds to the torso; and 37.1% for wounds to the head, face, or neck. Of 285 persons not reported to have died at the scene, 230 (80.7%) were taken to hospitals for evaluation, and 113 (39.7%) were admitted. The 20 persons killed by stray bullets and for whom data were available were survived by 58 children.

### Shooter and Weapon Characteristics

Altogether, 342 shooters were linked to the 284 study cases. Many were never identified, and an unknown number of others were also involved. Law enforcement authorities positively identified 98 stray bullet shooters. They were almost universally male, and 60.2% were aged 15 years to 34 years (Table 1).

Sixty-two stray bullet shooters were reported to have been charged with crimes, of whom 24 (38.7%) were known to have been convicted of offenses ranging from simple assault to first-degree murder and given sentences ranging from community service to life in prison without possibility of parole. Data were available for 59 stray bullet weapons; 36 (61.0%) were handguns, 21 (35.6%) were rifles, and 2 (3.4%) were shotguns.

### Differential Reporting

The case-fatality ratio for persons with stray bullet injuries that were incidental to interpersonal violence (27.9%, 51 of 183) was somewhat higher than the case-fatality ratio for persons killed or injured in firearm-related assaults nationwide in 2007 (20.6% [12,632 of 61,308]; difference = 7.3%; 95% CI, 1.3–14.2%). The case-fatality ratio for the small number of persons with nonstray bullet injuries in our cases (22.9%, 11 of 48) was higher as well, but this difference was not statistically significant (difference = 2.3%; 95% CI, –7.3–17.1%).

More news reports were identified for shootings involving stray bullet fatalities than for those involving nonfatal injuries (median [IQR]: 8 (4–11) for shootings with fatalities and 2 (1–4) for others,  $p < 0.0001$ ). There was no difference related to the victim's sex (median [IQR]: 3 (2–6) for females and 3 (1–6) for males,  $p = 0.47$ ) or age within or outside the range 15 years to 34 years (median [IQR]: 3 (2–6) for victims aged 15 years to 34 years and 3 (2–8) for others,  $p = 0.32$ ).

## DISCUSSION

Stray bullet shootings are a unique subset of firearm-related injury events. Most are unintended consequences of intentional violence; the euphemism “collateral damage” has long been applied to such unintended deaths in wartime. Based on these data, they are concentrated in large cities. Demo-

graphically, the victims resemble the general population, of which approximately half is female and 27% is in the age range 15 years to 34 years.<sup>34</sup> This is to be expected, because the victims were not participants in violence and were not selected as targets.

Most victims were unaware of the events leading to the gunfire that killed or injured them, and many were no doubt unaware of the gunfire itself. Under such circumstances, opportunities for preventive action to be taken once the shooting starts are limited. Minimizing exposure by fleeing the scene or taking cover is intuitively important, but there are no data on its effectiveness and some victims were shot while doing so. The benefits of taking cover indoors would likely be enhanced if residences were routinely equipped with bullet-proof safe areas, perhaps steel bathtubs or shower stalls. Protective gear, such as body armor and helmets, could be worn while outdoors. Such personal measures might be considered extreme, however, and would certainly be too expensive to be feasible on a population basis. Data on effectiveness are again lacking.

Some residents of communities where firearm-related violence is endemic already alter the patterns of their daily lives, minimizing their exposure preemptively.<sup>3–5,7–9</sup> There are no data on the prevalence or effectiveness of these measures, either. CDC has recommended staying indoors to prevent injuries on New Year's Eve.<sup>13</sup> This may be appropriate—police in Dallas, TX, received more than 1,500 shots-fired calls on New Year's Eve in 2008<sup>35</sup>—but the adverse consequences of extending that recommendation beyond brief periods of time would be substantial.

Community-level measures focused on stray bullet injuries have been taken with respect to celebratory gunfire. Since 1990, Los Angeles has banned ammunition sales for the 8-day periods ending January 1 and July 4.<sup>36</sup> A group of firearm retailers in the Atlanta area halted ammunition sales for the 4th of July holiday in 2010, in memory of a child killed by a stray bullet while at church the previous New Year's Eve.<sup>37</sup> To our knowledge, these policies have not been evaluated, and celebratory gunfire was an uncommon cause of stray bullet injuries in our data.

Reports for some shootings in our study that were not incidental to violence specified that local authorities did not intend to prosecute the shooter. Prosecution could be required for all acts of firing a gun intentionally and causing an unintended injury, even outside the context of interpersonal violence, with the intent of creating a deterrent. Experience with child access prevention laws suggests that this will not be effective, however, unless violations are prosecuted as felonies.<sup>38,39</sup>

Stray bullet shootings probably rise and fall in tandem with rates of firearm violence. Retaliation-interruption programs,<sup>40</sup> broad initiatives involving police and social agencies,<sup>41</sup> increased enforcement of firearms laws in high-crime “hot spots,”<sup>42,43</sup> and denial of firearm purchases by persons prohibited from possessing them<sup>44,45</sup> have all been at least provisionally shown to prevent firearm violence. Their benefits should perhaps be seen as reducing risk of firearm-related injury for all members of affected communities, not just for those who participate in violence.

Several limitations apply to our findings. The most important is the probability that we did not identify all stray bullet shootings occurring during our study period. To be included in our data, a shooting must have been reported on the Internet by a print or broadcast news organization, the report must have included one of our search terms, and the report must have been captured by one of our news retrieval services. Failures at any step would result in underascertainment. For this reason, we do not report rates. A broader search strategy, using terms such as bystander, drive-by, or accident, would have yielded many more shootings. The information needed to determine whether those shootings met our case criteria would often have been missing, we believe. We suggest designs for future studies below.

Few new cases were found in active searches, suggesting that our capture of cases that were reported at all was fairly complete. It is worth noting that many of the injuries in our cases were minor, and that among the 217 reported shootings that did not meet our case definition were 58 near misses and 48 in which stray bullets struck objects or animals. In these instances, at least, the reporting threshold was low. The possibility remains that eligible shootings were simply not reported or not captured and therefore not available to us. If decisions to report stray bullet shootings were related to characteristics of the event or the place in which it occurred, nonreporting would produce both an undercount and a bias in our data.

News report retrieval services have been used previously to conduct national surveillance for injuries not included in existing data systems, by CDC for school shootings<sup>46-48</sup> and by others for homicide-suicide.<sup>49</sup> Precisely because no complete reference data exist, news report data have never been validated at the national level.

Results of local or state-level studies have varied widely. Only 13.1% of homicides occurring in Los Angeles County, CA, during 1990 to 1994 were reported by the Los Angeles Times.<sup>50</sup> Beginning in January 2007, however, the Times has reported on the Internet on every homicide in the county.<sup>51</sup> Newspapers in Jefferson County, AL, where Birmingham is located, reported 84% of homicides overall in 1991 and a higher percentage of those involving firearms.<sup>52</sup> Newspapers reported 71% of homicide/suicides occurring in Dade and Hillsborough counties in Florida (containing Miami and Tampa, respectively) during 1997 to 1999.<sup>49</sup> In Utah, where National Violent Death Reporting System (NVDRS) data provided a statewide comparison, newspapers reported on 92% of homicides overall and 100% of homicide-suicides in 2005.<sup>53</sup>

Studies of homicide<sup>50,52,53</sup> and suicide<sup>53,54</sup> suggest that the perceived newsworthiness of a violent event strongly influences a media organization's decision whether or not to report it. Unexpected demographics, unusual circumstances, and other stories competing for space may all play a role. Two homicide studies suggest that reporting is more likely for events involving firearms, as all our cases do.<sup>50,54</sup> In Los Angeles County, reporting was more likely when the person killed was female or outside the age range 15 years to 44 years.<sup>50</sup> If this were true nationwide, biased reporting could affect our findings on victim demographics. Reporting is much more complete in the other homicide studies and is

highest in the one available statewide study,<sup>53</sup> suggesting that the bias found in Los Angeles during the early 1990s may be atypical.

Taken together, the three homicide studies<sup>50,52,53</sup> suggest that shootings occurring outside major population centers may be more likely to be reported than those occurring in large cities. If this is true, our data may underestimate the extent to which stray bullet shootings are predominantly an urban phenomenon.

We found a difference in case-fatality ratios between persons with stray bullet injuries in our cases and victims of firearm assault nationwide. This, along with our identifying more news reports for shootings involving stray bullet fatalities than for those involving nonfatal injuries, suggests that there was some differential in reporting by injury severity. The magnitude of differential reporting seen here is a marked and favorable difference from results in the California and Alabama studies,<sup>50,52</sup> where reporting of homicide was much more complete than reporting of nonfatal assault.

The net effect of these factors on our data are impossible to determine. Stray bullet shootings may be seen as particularly newsworthy: the circumstances are unusual, the persons who are shot are not to blame, and fear of random victimization is known to have pervasive effects on communities in which stray bullet shootings occur frequently.<sup>3-5,7-9</sup> This remains a matter for speculation and further research.

Our findings are also limited by the frequency of missing data, particularly for shooters and weapons and for long-term clinical and criminal justice outcomes. More information was available for fatal cases than others, as measured by number of news articles retrieved, a phenomenon that has been observed before.<sup>50</sup> No such differential was seen related to victim demographics.

Future research might combine active surveillance or more inclusive passive surveillance, with follow-up access to criminal justice, medical, and medical examiner records or interviews of victims and others to identify all cases and obtain more complete data. Surveys in high-risk areas could document the prevalence and range of exposure to gunfire in the general population, and case control studies might shed light on risk factors and the effectiveness of protective measures. The NVDRS might be a valuable resource. NVDRS does not have a code for stray bullet shootings,<sup>55</sup> but its detailed case narratives might make it possible to determine which shootings qualified as cases. NVDRS covers only fatal events in 16 participating states with a nonrepresentative 26% of the population.<sup>56</sup>

#### AUTHORSHIP

G.J.W. conceived of and designed the study, conducted analysis, wrote the manuscript, and obtained funding. B.E.C. assisted with study design, collected data, and provided critical input on manuscript. V.S.M. assisted with study design, collected data, and provided critical input on manuscript. M.A.W. assisted with study design, collected data, and provided critical input on manuscript.

#### ACKNOWLEDGMENT

We thank Philip Alpers, School of Public Health, University of Sydney, for his observations on stray bullet shootings.

#### DISCLOSURE

The authors declare no conflicts of interest.

## APPENDIX: SUMMARIES OF SELECTED CASES

### Shootings Incidental to Interpersonal Violence North Carolina: October 2008

A 9-year-old male was asleep at his church's annual camp meeting, attended by at least 1,500 people, when an argument just after midnight led to gunfire. Multiple shooters were involved. A stray .38-caliber bullet traveled 50 feet to 60 feet and through the fabric wall of a food vendor's booth, striking the boy in the head. His mother and grandmother were beside him at the time. He was airlifted to a regional trauma center, where he was pronounced dead. No one else was injured. The stray bullet shooter was charged with murder; four others were charged with lesser offenses.

### Illinois: April 2008

A 40-year-old male had driven to the store with his two sons, aged 8 years and 11 years, to purchase school supplies. As they walked across the parking lot, holding hands, a fight broke out between members of the Latin Kings and the Vice Lords at a nearby sandwich shop. One man fired three or four rounds from a handgun. The victim was struck in the back and fell to the ground; his sons fled into the store. He was pronounced dead at a nearby hospital half an hour later. The shooter turned himself in and was charged with murder. Seven other participants were also charged. The victim was married and had three children.

### Ohio: August 2008

A 51-year-old female was crossing the street, about a block from her home, to go to the store. Nearby, four male teenagers were engaged in a dispute arising from one stepping on another's shoes. One of them drew a pistol. As his two opponents fled, he fired four shots; one of the fleeing teenagers was struck in the hip and a stray bullet struck the woman in the neck. She was paralyzed immediately and died 3 weeks later of sepsis. The shooter was convicted of murder and other offenses and faced a sentence of up to life in prison. Four days after this shooting, a female of unknown age, driving home from work down that same street, was wounded by a stray bullet as teenagers fired across the street at one another. Two hours after that, a 17-year-old was shot in what police believed to be retaliation for the shooting of the driver.

### California: April 2008

A 21-year-old female was asleep in bed in her apartment, her younger sister beside her. Nearby, a memorial service was under way for a female teenager, a resident of another apartment, who had been shot and killed 3 years earlier. A drive-by shooting ensued; three people attending the service were wounded. One stray bullet penetrated the wall of the 21-year-old's apartment, striking her in the head. She was not found until an hour later, by her mother, who was awakened by police canvassing the neighborhood. Her sister, unharmed, was still asleep; a second bullet had narrowly missed her. The 21-year-old, who had a 1-year-old child, died at the hospital 2 days later. A third stray bullet struck an 18-year-old female, who had been in bed in another apartment, in the leg. Her wound was superficial. She was pregnant.

### Shootings Resulting From Celebratory Gunfire Indiana: January 2009

A 13-year-old female was struck in the leg just after midnight on New Year's Eve by a bullet that penetrated the wall or roof of her home. The shooter had fired at least a dozen rounds from an AR-15 rifle from outside his home, ~200 yards away. At least two other rounds struck the victim's home, one penetrating the refrigerator and another striking the television. The victim underwent surgery at a nearby hospital; her injury was not life threatening. The shooter was charged with criminal recklessness resulting in bodily injury.

### Shootings Incidental to Gun Maintenance and Handling New Jersey: August 2008

A 15-year-old male was asleep in his bedroom in a second-floor apartment. In the apartment below, a 19-year-old male was trying to unload his Norinco SKS 7.62 mm rifle when it fired. The bullet traveled through the ceiling, the floor of the apartment above, and the victim's mattress before striking the victim in the back of the head. His mother heard the shot and found him. He was pronounced dead at a nearby hospital. The shooter, who had no criminal record, and his family reported that he had acquired the rifle for protection after being robbed and assaulted. He was charged with aggravated manslaughter and illegal possession of a firearm.

### Shootings Incidental to Hunting and Sporting Activities New York: November 2008

A 16-month-old female was standing with her grandmother in the kitchen of her grandparents' home, where her family had gathered to watch football. Approximately 500 feet away, an experienced hunter in a tree stand, armed with a .300-caliber Winchester Magnum rifle, shot and wounded a deer. He descended and fired again from ground level, 378 feet from the home. His second shot missed the deer, penetrated the wall of the home, and struck the child in the upper torso. Relatives took her by car to a local hospital, and she was airlifted to a regional medical center. She died later that day. The shooter, whose 12-year-old daughter had died from an astrocytoma 2 years earlier, pleaded guilty to second-degree manslaughter to save the victim's family the pain of the trial.

### Vermont: September 2008

A 73-year-old male, a retired English professor with seven children, had just sat down to dinner with his wife when a bullet came through the window, striking him in the heart. He died within minutes. When police arrived, they heard gunfire nearby. In the next door neighbor's backyard, ~700 feet away, they found four men taking turns firing several weapons at a homemade shooting range, including the SKS rifle from which the stray bullet had come. It proved impossible to determine which man had fired the stray bullet. The neighbor, who had passed a hunter safety course 10 days before the shooting, was sentenced to 2 years in prison for involuntary manslaughter. A second shooter, who owned the SKS, pleaded guilty and was sentenced to 60 days in jail. The others

were not charged. The victim had been the caregiver for his wife, who was disabled; 2 years later, she was living in a nursing home.

## Shootings Under Other or Unknown Circumstances

### Nebraska: April 2008

A 14-year-old male soccer player was on his home school field, watching his team from the sidelines, when he was struck in the cheek by a bullet that authorities believed was fired from some distance away and hit him while falling. The school was locked down for about 30 minutes after the shooting; during this time, students were not allowed to answer cell phone calls from their parents. At about the same time, gunfire was reported at an elementary school less than a mile away. An initial investigation identified several suspects, but ballistics tests failed to link their firearms to the bullet that struck the victim. The shooter was not identified. The victim required surgery and lost nine teeth.

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