Temporal variation in United States firearm injuries 1993-2008: results from a national data base

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KEY WORDS

Firearm Injury Temporal variation Month Weekday

Abstract:

Background: There are few studies that address temporal variation in firearm associated injuries. It was the purpose of this study to analyze the temporal variation in the types and patterns of injuries associated with firearm use from a national data base.

Methods: The database used was the Inter-University Consortium for Political and Social Research Firearm Injury Surveillance Study 1993-2008. Emergency department visits associated with firearm use were analyzed for month and day of the week for various demographic variables. Statistical analyses were performed using SUDAAN 10™ software to give national estimates. Temporal variation by month or day was assessed using histograms, circular distributions, and cosinor analyses. Variation by month and day combined were analyzed using three dimensional contours.

Results: There were an estimated 1,841,269 injuries. Circular analyses demonstrated a non-uniform distribution for all parameters for both month and day of injury ($p$ less than 0.001). The overall peak was September 15 with several exceptions. Injuries from BB guns had a peak on May 22, a diagnosis of a foreign body on July 11, and patients aged 10 to 14 years on April 9. The peak day was always Saturday/Sunday when significant variation existed. There were many different patterns for month and day combined. Some were “a rapidly rising high mountain starting at sea level” (hunting), or others a “series of mountain ranges starting from a high plain or steppe” (hospital admissions).

Conclusions: This study provides altogether new information regarding temporal variation for injuries associated with firearms in the USA. These results can be used to assist medical resource allocation and prevention campaigns. Education campaigns can be emphasized before the peaks for which prevention is desired (eg. BB gun prevention campaigns should be concentrated in March, prior to the April/May peak).

Introduction

Injuries due to firearms are a significant health burden in the United States of America. The number of studies addressing gunshot injuries is voluminous, but few address temporal variation of such injuries and none have mathematically modeled any temporal patterns when found. It was the purpose of this study to mathematically analyze the temporal variation in the types and patterns of injuries associated with firearm use from a national data base. This allows for a more general view, rather than a microscopic view. Such in-
formation can be used to assist health care providers and institutions caring for such patients to better allocate resources at both outpatient and inpatient levels. It can also guide appropriate timing for education and prevention campaigns in an effort to reduce these injuries.

Methods

The data for this study was obtained from the Inter-University Consortium for Political and Social Research Firearm Injury Surveillance Study 1993-2008 (ICPSR 30543)® collected by the National Electronic Injury Surveillance System (NEISS). Further details regarding the acquisition of the ICPSR/NEISS data and guidelines for use of such data can be accessed from their respective web sites (ICPSR - www.icpsr.umich.edu, NEISS - www.cpsc.gov/library/neiss.html). The data for emergency department (ED) visits associated with firearm use from 1993 through 2008 was downloaded from the ICPSR website. It was analyzed for month and day of the week by hospital stratum, age, diagnosis, gender, race, marital status, type of firearm, perpetrator of injury, intent of injury (unintentional, assault, suicide, law enforcement), anatomic location of the injury, geographic location of where the injury occurred, method of transportation to the ED, disposition from the ED, was the patient shot/not shot, and the involvement of drugs/crime/fight/argument in the incident. (Not all firearm injuries occur when the person is shot, such as a firearm used as a blunt club in an assault, or a clavicle fracture from a rifle recoil). Race was classified according to Eveleth and Tanner11 as White, African, Amerindian (Hispanic and Native American) and Indo-Malay (Asian origins). The NEISS does not differentiate hospital locations by urban, suburban, rural; however, there are 5 strata designated by number of ED visits per year. These strata and their number of annual ED visits are: small (1-16,830), medium (16,831-28150), large (28,151-41,130), very large (> 41,130), and children’s hospitals (various numbers). Such strata can be viewed as a general proxy for rural (small), suburban (medium), and urban locations (large, very large).

Individual comments for each injury were searched to ascertain if either alcohol or hunting was involved. The detailed comments for each injury (recorded in the ICPSR data set) were searched using the FIND command in Microsoft Excel™ (Microsoft® Office 2003, Microsoft Corporation 1985-2003). The key words used to search for any injury involving alcohol were: alcohol, EtOH, intoxicated, drinking, drank, drunk, club, ethanol, saloon, tavern, liquor, boozed, beer, whiskey, brandy, rum, vodka, scotch, tequila, wine, sake, champagne, and cognac. The key words used to search for any injury involving hunting were: hunting, deer, elk, moose, bear, antelope, coyote, lion, wolf, boar, hog, groundhog, prairie dog, squirrel, rabbit, coon, beaver, waterfowl, goose/geese, turkey, duck, quail, coon, pheasant, bird, sparrow.

As this is an exploratory study with no previous studies mathematically assessing the question of temporal variation in firearm associated injuries, there were no preconceived expectations. However, it could be postulated that there should be no difference in any monthly variation by gender, or race. Another hypothesis is that injuries sustained from shotguns and rifles, frequently used in hunting, would follow any patterns observed in the hunting group, while handguns, typically used in an assault situation would follow similar patterns to assaults. Regarding age, it is postulated that younger children would see an increase at the year end holiday when receiving firearms as presents, teenagers would demonstrate a peak in hunting season, young adults would show no significant variations due to them mostly being involved in violent events (assaults, crimes) which are likely to be uniform throughout the year, and that older adults would again demonstrate peaks during hunting season. Those injured by themselves or unintentional injuries would likely be hunting and show a similar pattern to hunting injuries. Suicides would likely be random with no temporal variation. Those injured on the street/highway would likely be assaults and demonstrate similar patterns; those injured on farms would likely be due to hunting activities and should follow similar patterns; those injured at homes would be random. Rural injuries (small hospitals) are hypothesized to demonstrate similar patterns to these seen on farms or while hunting; assaults would show patterns seen in the urban (large and very large hospitals). It is postulated there will be an increase in injuries on the weekend, when more people are not working.

It was also desired to specifically explore patterns by the type of event (assault, unintentional) and by perpetrator. Such analyses might uncover differences in peaks by subgroups, and point towards specific potential preventive campaigns.

Statistical Analyses

Due to the stratified and weighted nature of the ICPSR data, statistical analyses were performed using SUDAAN 10™ software (RTI International, Research Triangle Park, North Carolina, 2008). This software accounts for the weighted and stratified nature of the data and calculates an estimated value across an entire population encompassed by the data set. In this case the ICPSR represents the entire United States of America.
The estimated values of firearm injuries by month and year were so determined.

Several methods were used to analyze for temporal variation. The first was a simple review of the data as seen in histograms. This was then quantified using circular distribution which converts the data to a circular scale. The rectangular coordinates of an angle representing each month (360°/12 = 30° per month) or day (360°/72 = 51.4° per day) are calculated for each data point, using January as an angle of 0 and November as an angle of 330 and Sunday as an angle of 0 and Saturday as an angle of 308.4°. Each angle’s sine and cosine are represented on an x and y axis. From these data, the average month/day is the angle determined by the average of the sine and cosine components (angular mean), with a radius amplitude (r), and circular standard deviation or angular dispersion (s). The Rayleigh z-test was used to test for non uniformity in circular distribution. When the Rayleigh z-test demonstrated non uniformity in circular distribution, cosinor analysis was used to determine best fits for the data. Cosinor analysis is an extension of circular distribution and represents the mathematical best fit of the data to a cosine curve defined by the equation

\[ F(t) = M + Acos(\omega t + \phi) \]

where \( M \) = the mean level (termed mesor), \( A \) = the amplitude of the cosine curve, \( \phi \) = acrophase (phase angle of the maximum value), \( \omega \) = the frequency (which for monthly analysis is 360°/12 = 30° or for week day analysis is 360°/7 = 51.4°), and \( t = \) time (which in this case is each month or day). The overall \( p \) and \( r^2 \) value for the goodness of fit of this equation were noted. When the \( p < 0.05 \), the data is not a uniform circular distribution but rather represents a rhythmic pattern described by the cosinor equation for \( M, A, \) and \( \phi \) (Figure 1). The data were analyzed for the entire period of 12 months (monthly variation) and 7 days (weekday variation), as well as decreasing increments of 1 month or 1 day respectively. On occasion, the best monthly fit was not over a period of 12 months, but a different time span (e.g. 5 or 6 months periodicity). Differences between statistically significant cosinor fits were assessed with the Bingham test. Cosinor analyses were performed with ChronoLab 3.0™ software (see Acknowledgement). For all analyses, a \( p < 0.05 \) was considered statistically significant.

Differences by both month and day were analyzed using a previously described method analogous to a topographical map with “contours of elevations”, since 3 dimensional cosinor analyses do not presently exist. The number of ED visits was plotted onto a topographical “map” with the month on the x axis, the weekday on the y axis, and the number of ED visits on the z axis (or “elevation” of the contour). Twenty equal “contour elevations” were used to create the “topographic maps” (Figure 2). These 3 dimensional topographic contours were created using DPlot Software 2.3.3.1 (Hyde Soft Computing LLC, Vicksburg, MS, 2001-2012) and subjectively reviewed to determine the “peaks” for each variable.

**Results**

There were 61,419 firearm injuries in the ICPSR data base between 1993 and 2008, resulting in an estimated 1,841,269 injuries. Circular analyses demonstrated a non-uniform distribution for all parameters for both month and day of injury (all \( p <0.001 \)).

**General Exploratory Analyses**

Not all parameters demonstrated statistically significant fits using cosinor analysis for either month or weekday (Table 1). The overall peak month was September 15 (Figure 1). Although the majority of the peaks were in late summer and autumn, there were several exceptions. Injuries from BB guns had a peak on May 22, a diagnosis of a foreign body on July 11, and patients aged 10 to 14 years on April 9. There were several parameters with bimodal fits (two peaks throughout the year) (Figure 3A, 3B). These were those injured at school/places of recreation (May 5 and November 4), those injured during law enforcement activities (May 1 and October 31), those whose ages were 45 to 54 years (May 21, November 19), > 55 years (May 14, November 12), and > 65 years (May 16, November 14). There were other parameters that had significant cosinor fits, but such fits...
were not visually the best model due to a particular higher peak (e.g., hunting, rifles, shotguns) (Figure 4). The overall peak day was on the weekend, usually at 2400 Saturday/0000 Sunday for those parameters that demonstrated a significant fit. There was no weekday pattern for those who were divorced/separated, injured during law enforcement activities, or suicides.

Month by weekday topographic maps demonstrated many different patterns. Some were “a rapidly rising high mountain starting at sea level” such as with hunting activities (Figure 2), or others demonstrating a “series of mountain ranges starting from a high plain or steppe” (Figure 5). The peak tabulations for month and day (up-
Table 1: Cosinor analyses by month and weekday for an estimated 1,841,269 firearm injuries 1993-2008 using the ICPSR national data base

| Parameter                  | n    | Month   | Weekday |
|----------------------------|------|---------|---------|
| All                        | 1841359 | 15-Sep | Sat/Sun |
| Gender                     |      |         |         |
| Male                       | 1593448 | 17-Sep | Sat/Sun |
| Female                     | 247256  | 24-Aug | Sat/Sun |
| Race                       |      |         |         |
| White                      | 662276  | 4-Nov   | Sat/Sun |
| African                    | 634078  | 11-Aug  | Sat/Sun |
| American                   | 254552  | -       | Sat/Sun |
| Asian                      | 20406   | -       | Sat/Sun |
| Firearm                    |      |         |         |
| Handgun                    | 498848  | 1-Oct   | Sat/Sun |
| Rifle                      | 109679  | 7-Nov   | -       |
| Shotgun                    | 103475  | 30-Oct  | Sat/Sun |
| BB                         | 354776  | 22-May  | Sat/Sun |
| Diagnosis                  |      |         |         |
| Contusion/ Abrasion        | 114995  | -       | Sat/Sun |
| Foreign Body               | 244095  | 11-Jul  | Sat/Sun |
| Laceration                 | 103558  | 25-Oct  | Sat/Sun |
| Puncture                   | 245317  | 18-Aug  | Sat/Sun |
| Internal Injury            | 66120   | 5-Sep   | Sat/Sun |
| Fracture                   | 695964  | 29-Sep  | Sat/Sun |
| Anatomic Area              |      |         |         |
| Head/Neck                  | 543507  | 26-Oct  | -       |
| Upper Trunk                | 268025  | 10-Aug  | -       |
| Lower Trunk                | 199054  | 12-Aug  | Sat/Sun |
| Arm/Hand                   | 341952  | 17-Aug  | Sat/Sun |
| Leg/Foot                   | 444352  | 30-Aug  | Sat/Sun |
| Location                   |      |         |         |
| Home                       | 498935  | 7-Nov   | -       |
| School/Rec                 | 51301   | -       | -       |
| Strt/Hghwy                 | 305153  | 17-Aug  | Sat/Sun |
| Other Prop                 | 202665  | 22-Oct  | -       |
| Farm                       | 6071    | 22-Nov  | -       |
| ED Transport               |      |         |         |
| EMS                        | 398662  | 29-Aug  | Sat/Sun |
| Air                        | 286959  | 17-Sep  | Sat/Sun |
| Priv Vehic                 | 144053  | 18-Aug  | Sat/Sun |
| Walk In                    | 44059   | -       | Sat/Sun |
| Police                     | 520716  | 28-Oct  | Sat/Sun |
| Other                      | 45311   | 5-Aug   | Sat/Sun |
| Hospital Stratum           |      |         |         |
| Small                      | 377098  | -       | Sat/Sun |
| Medium                     | 317928  | -       | Sat/Sun |
| Large                      | 493311  | 31-Aug  | Sat/Sun |
| Very Large                 | 634992  | 5-Sep   | Sat/Sun |
| Children’s                 | 17940   | 9-July  | Sun     |
| Perpetrator                |      |         |         |
| Stranger                   | 469554  | 8-Sep   | Sat/Sun |
| Self                       | 469554  | 18-Nov  | Sat/Sun |
| Friend/Acq                 | 138549  | -       | Sun     |
| Spouse/Ex                  | 13589   | -       | Sat     |
| Other Relative             | 55904   | -       | -       |
| Not Seen/Other             | 241669  | 29-July | Sat/Sun |

| Parameter                  | n    | Month   | Weekday |
|----------------------------|------|---------|---------|
| Incident Type              |      |         |         |
| Unintentional              | 530023 | 24-Nov  | Sat/Sun |
| Assault                    | 953359 | 17-Aug  | Sat/Sun |
| Suicide                    | 92623  | -       | Sat/Sun |
| Law Enforcement            | 21368  | -       | -       |
| Marital Status             |      |         |         |
| Never                      | 669628 | 1-Sep   | Sat/Sun |
| Married                    | 228859 | 3-Nov   | Sat/Sun |
| Divorce/Sept               | 44919  | 29-Aug  | Sat/Sun |
| Other                      | 24238  | 12-Aug  | -       |
| Disposition from ED        |      |         |         |
| Released                   | 1181291| 20-Sep  | Sat/Sun |
| Admitted                   | 555659 | 1-Sep   | Sat/Sun |
| Fatality                   | 95222  | 24-Aug  | Sat/Sun |
| Argument                   |      |         |         |
| Yes                        | 121885 | 27-Sep  | Sat/Sun |
| No                         | 626144 | 8-Nov   | Sat/Sun |
| Crime                      |      |         |         |
| Yes                        | 238628 | 6-Sep   | Sat/Sun |
| No                         | 619793 | 9-Nov   | Sat/Sun |
| Drugs                      |      |         |         |
| Yes                        | 58453  | -       | -       |
| No                         | 625734 | 15-Nov  | Sat/Sun |
| Fight                      |      |         |         |
| Yes                        | 149301 | 8-Sep   | Sat/Sun |
| No                         | 651145 | 8-Nov   | Sat/Sun |
| Rape                       |      |         |         |
| Y                          | 9089   | -       | -       |
| N                          | 1822270| 15-Sep  | Sat/Sun |
| Shot                       |      |         |         |
| Y                          | 1418741| 11-Aug  | Sat/Sun |
| N                          | 432168 | 19-Oct  | Sat/Sun |
| EiOH                       |      |         |         |
| Y                          | 9089   | 20-Sep  | Sat/Sun |
| N                          | 1822270| 20-Sep  | Sat/Sun |
| Hunting                    |      |         |         |
| Y                          | 35965  | 17-Nov  | Sat/Sun |
| N                          | 1805839| 1-Sep   | Sat/Sun |
| Age Group (years)          |      |         |         |
| 0 to 4                     | 13969  | -       | Sat/Sun |
| 5 to 9                     | 56462  | -       | Sat/Sun |
| 10 to 14                   | 173035 | 9-Apr   | Sat/Sun |
| 15 to 19                   | 382684 | 28-Aug  | Sat/Sun |
| 15 to 24                   | 365909 | 6-Sep   | Sat/Sun |
| 20 to 24                   | 406923 | 28-Sep  | -       |
| 25 to 34                   | 231299 | 2-Oct   | Sat/Sun |
| 35 to 64                   | 110784 | -       | Sat/Sun |
| 55 to 64                   | 50101  | -       | Sun     |
| 65+                        | 39765  | -       | -       |
| 0 to 14                    | 243458 | -       | Sat/Sun |
| 15 to 34                   | 1155674| 8-Sep   | Sat/Sun |
| 35 to 54                   | 342083 | 8-Oct   | Sat/Sun |
| 55+                        | 89866  | 17-Oct  | -       |

per 2 levels of red) are given in Table 2, and various examples are graphically shown in Figure 6.
Subgroup Patterns by Incident Type and Perpetrator

The detailed results for month are shown in Table 3. Injuries from suicides and law enforcement, and when the perpetrator was a spouse/ex or other relative were excluded due to small numbers. Unintentional injuries were predominantly in the autumn months, and assaults in the summer; notable exceptions for unintentional injuries were BB guns with a peak in April, those occurring at home in January, and those in the 0 to 14 year age group in February. Nearly all the self inflicted injuries occurred in the autumn months regardless of subgroup, those by strangers in the late summer/early autumn, and in the summer when the perpetrator was not seen. All significant weekday results always occurred on the weekends; thus no detailed results are shown.

Discussion

Limitations of the study must first be acknowledged. One limitation of the NEISS data is that it only identifies those individuals who sought care in the ED. It does not include those who might have been treated in urgent care centers, physician offices, or those patients who did not seek medical care. The overall number of injuries in this study is therefore lower than the real number of injuries. The NEISS is thus skewed to more serious injuries, since patients sustaining significant injuries will likely seek immediate care in the ED. Another potential limitation is the accuracy of the NEISS data. However it appears to have an accuracy of at least mid 90%. With small numbers of individuals per category, the estimated national number estimates may be subject to some inaccuracy. With these caveats in mind, this new detailed background data can serve as a reference for future studies regarding the temporal variation of injuries associated with firearms.

This is the first study using a large national data base to determine temporal variations in injuries from firearm use. There are several studies that have looked at this question in their local area, but none with any mathematical modeling. In Pretoria, South Africa there were peaks in March and September. In Finland, there was a peak in September and October with no mention of the weekday. In Manchester, England there was no pattern regarding day of injury. In Illinois, assaults from firearm injuries demonstrated a peak on Fridays. In a study of stray bullet shootings in the United States, there was a peak in the summer and on Thursdays. Gunshot injuries in south central Los Angeles were more frequent in the summer months; in Africans, there was uniform distribution throughout the week, while for Hispanics they were concentrated on Saturday through Monday. Craniofacial gunshot wound injuries in Tehran, Iran had a peak in January, with no mention of the weekday. In children 0 to 19 years old from East Baton Rouge, Louisiana, there were peaks in the summer and December; 24% occurred on Friday and 20% on Sunday. In Alabama children a peak was noted in the block squares and solid black line) and while hunting (open triangles and hatched line). There were statistically significant fits for both rifles (Number ED visits = 9136 + 4035cos((30t-15)-307), r² = 0.50, p = 0.042, peak November 17) and hunting (Number ED visits = 2991 + 3723cos((30t-15)-317), r² = 0.62, p = 0.013, peak November 7) although the month of November was a significant outlier for both (outlined by the dotted octagon).

Figure 5: Three dimensional topographic contour for those who were admitted to the hospital for injuries associated with a firearm. Note the starting level of 4800 patients “medium altitude plain” with various “rising mountain ranges”, the tallest one at 10,377 patients (Saturday/Sunday in October/November), but also with 2 other peaks (Saturday in January, and Saturday/Sunday in May/June).
half of the year (July through December). In 749 children from the National Pediatric Trauma Registry, 156 (53.4%) of unintentional injuries occurred Friday-Sunday; no monthly data was given.

Other studies assess only fatalities. Accidental firearm fatalities in Tennessee children and teenagers demonstrated two peaks, one in November and one June; rural deaths were more common in November.
while urban deaths were more common in June. Most accidental firearm hunting deaths in Sweden occurred September through December and on Saturday/Sunday. A study of 444 firearm fatalities in Diyarbakir, Turkey.

Figure 6: Variations in firearm associated injuries by both month and weekday as shown on two dimensional topographic contour representations.
demonstrated that there were more homicides in spring and summer, while there were more suicides and accidental deaths only in the spring. In Cagliari, Italy, firearm suicides were the highest in February with no variation in day of the week. In Bari, Italy, 28 of 82 suicides from firearms occurred in November through January, although there was no real pattern. In three United States cities (Allentown, Pennsylvania; Youngstown, Ohio; Cedar Rapids, Iowa) the number of suicides were relatively equal October to March and April to September; 63-72% of the suicides occurred on the weekdays and the remainder on weekends.

The data from several of these studies in the literature, where available, was extracted and subjected to cosinor analysis (Table 4). For monthly variation, the peak was September 26 in Finland for all injuries and

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**Figure 6:** Variations in firearm associated injuries by both month and weekday as shown on two dimensional topographic contour representations.

D: By perpetrator.

E: By marital status
Sept 27 for unintentional injuries. In Los Angeles the peak for all patients was July 4 and for Africans June 27. Hunting deaths in Sweden had a peak on October 6. Head injuries from firearms in Iran demonstrated a peak on December 30. There was no difference by the Bingham test between Finland and our USA data set for all injuries, but there was a difference in unintentional injuries (Sep 27 vs Nov 24, p = 0.018). Similarly the data from Los Angeles was different than the USA data set for all injuries (July 4 vs Sept 16, p = 0.007) and Africans (June 27 vs Aug 11, p = 0.029). There was a difference in head injuries between Iran and the USA data (Dec 30 vs Oct 26, p = 0.001). Those injured by stray bullets in the USA or children 0 to 19 years of age in East Baton Rouge, Louisiana demonstrated no significant cosinor fit. For weekday variation, the only significant cosinor fit was for the Hispanic patients in southern Los Angeles (Sunday, p = 0.01), which was not statistically different from the Saturday/Sunday in our Amerindian group (Bingham test, p = 0.14).

Several of our hypotheses proved true, while others did not. It was hypothesized that there would be more

![Graphs showing variations in firearm associated injuries by both month and weekday as shown on two-dimensional topographic contour representations.](image-url)

**F:** By age group.

**G:** By incident type.

Figure 6: Variations in firearm associated injuries by both month and weekday as shown on two-dimensional topographic contour representations.
injuries on the weekend when people were not working, which was statistically confirmed by a peak at 2400 Saturday/0000 Sunday. As postulated there were no differences in monthly peaks between males and females (Sep 17 and Aug 24, p = 0.17). We postulated no differences by race; however there were differences between Whites and Africans (Nov 4 vs Aug 11, p = 0.013). As postulated injuries from rifles and shotgun had peaks on Nov 7 and Oct 30, similar to hunting peak on Nov 17 (rifle vs hunting p = 0.19, shotgun vs hunting p = 0.43). It was hypothesized that handguns would have a peak similar to that of assaults; however, that was not so, with the peaks for assaults being Aug. 17 and handguns Oct 1 (p = 0.012). When looking at different age groups, the hypothesis that younger children would have a year end peak due to the holiday season was not seen as there was no significant peak for those 0 to 14 years old. Teenagers 15 to 19 years of age did demonstrate a peak of Aug 28, but still different from the postulated hunting peak of Nov 17 (p = 0.015). The hypothesis that young adults would demonstrate no significant monthly variation as most would be violent events, which would likely be uniform throughout the year, was not proven; those 15 to 34 years of age had a peak of Sep 8, and those involved in a crime had a peak of Sep 6. Older adults demonstrated a peak

Figure 6: Variations in firearm associated injuries by both month and weekday as shown on two dimensional topographic contour representations.
similar to those with hunting injuries (> 55 years – Oct 17, hunting – Nov 17, p = 0.33). Regarding incident types, there was no peak for suicides, as postulated. Unintentional injuries were confirmed to show patterns similar to hunting (Nov 24 vs Nov 17, p = 0.80). Those injured on street/highways were postulated to be similar to assaults which was confirmed with street/highways and assaults both on Aug 17. The hypotheses that those injured on farms would be similar to those involved in hunting activities was confirmed (Nov 22 vs Nov 17, p = 0.91). Those injured at home were not random as postulated, but had a peak on Nov 7. It was confirmed that those injured by themselves were similar to hunting (Nov 18 vs Nov 17, p = 0.85) and unintentional injuries (Nov 18 vs Nov 24, p = 0.80). It was postulated that small hospitals would have peaks similar to hunting and farm injuries; however small hospitals demonstrated no monthly pattern. It was confirmed that the peak for assaults was similar to large (Aug 17 vs Aug 3, p = 0.40) and very large (Aug 17 vs Sep 5, p = 0.97) hospitals.

Analyses within the subgroups demonstrated interesting findings. Those injured at home in aggregate demonstrated a peak on Nov 7; however unintentional home injuries peaked Jan 2 while assaults were Sep 4 (p = 0.001). Those who were shot had an overall peak on Aug 11; but those who were shot unintentionally had a peak on Nov 14 and those who were assaulted Aug 12 (p < 0.0001). Those who were 0 to 14 years of age had no peak in aggregate; however those 0 to 14 years of age who were assaulted had a peak on June 19 and

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**Table 3: Subgroup cosine analyses by month**

| Gender     | Unintentional | Assault | Stranger | Self | Friend/Acq | Not Seen/Other |
|------------|---------------|---------|----------|------|------------|----------------|
| Male       | 24-Nov        | 17-Aug  | 14-Sep   | 26-Nov| 22-May, 21-Oct | 28-July         |
| Female     | 23-Oct        | 17-Aug  | 7-Sep    | -    | -          | -              |

| Race       | Unintentional | Assault | Stranger | Self | Friend/Acq | Not Seen/Other |
|------------|---------------|---------|----------|------|------------|----------------|
| White      | 23-Nov        | 3-Sep   | 18-Sep   | 22-Nov| 25-May, 21-Oct | -              |
| African    | 29-Jan        | 9-Sep   | -        | 3-Feb, 3-Nov | -          | 7-Aug          |
| Amerindian | -             | -       | -        | -    | -          | -              |
| Asian      | -             | -       | -        | -    | -          | -              |

| Firearm    | Unintentional | Assault | Stranger | Self | Friend/Acq | Not Seen/Other |
|------------|---------------|---------|----------|------|------------|----------------|
| Handgun    | 16-Jan, 18-Nov| 30-Aug  | 11-Oct   | 22-Jan, 22-Nov | 30-Aug | -              |
| Rifle      | 8-Nov         | -       | 9-Nov    | 5-Oct | -          | -              |
| Shotgun    | 14-Nov        | 4-Aug   | 1-Sep    | 20-Nov| 27-May, 26-Oct | 26-Apr, 25-Sep |
| BB         | 17-Apr        | 2-July  | 11-Jun   | -    | -          | 1-July         |

| Anatomical Area | Unintentional | Assault | Stranger | Self | Friend/Acq | Not Seen/Other |
|-----------------|---------------|---------|----------|------|------------|----------------|
| Head/Neck       | 21-Nov        | -       | 3-Oct    | 14-Nov| -          | 22-Aug         |
| Upper Trunk     | 16-May, 15-Nov| 7-Aug   | -        | -    | -          | -              |
| Lower Trunk     | 7-May, 6-Nov  | 12-Aug  | -        | -    | 12-Aug     | -              |
| Arm/Hand        | 7-May, 6-Nov  | 5-Aug   | 22-July  | 7-May, 6-Nov | 15-July | 5-Mar, 5-Jul, 4-Nov |
| Leg/Foot        | 12-Dec        | 14-Aug  | 11-Sep   | 13-Dec| -          | 26-July        |

| Location        | Unintentional | Assault | Stranger | Self | Friend/Acq | Not Seen/Other |
|-----------------|---------------|---------|----------|------|------------|----------------|
| Home            | 2-Jan         | 4-Sep   | 23-Nov   | 5-Dec| -          | 30-July        |
| School/Rec      | 13-Nov        | 30-June | 13-July  | 12-Nov| -          | 5-Sep          |
| Street/Highway  | 16-Aug        | -       | 22-Aug   | -    | 29-July    | 5-Mar          |
| Other Prop      | 5-Nov         | -       | 6-Nov    | 9-Nov| 5-Mar, 5-Jul, 4-Nov | -              |
| Farm            | 23-Nov        | -       | -        | -    | -          | -              |

| Hospital Stratum | Unintentional | Assault | Stranger | Self | Friend/Acq | Not Seen/Other |
|------------------|---------------|---------|----------|------|------------|----------------|
| Small            | 22-Nov        | 23-July | -        | 24-Nov| 25-May, 24-Oct | 15-May, 16-Nov |
| Medium           | 11-Sep        | 15-Sep  | -        | -    | 10-Aug     | 29-July        |
| Large            | 11-Aug        | 30-Aug  | -        | 13-July| 29-July    | 29-July        |
| Very Large       | 1-April, 1-Aug, 1-Dec | 16-Aug | 13-Sep | 5-Aug | 29-July |

| AgAge (years)    | Unintentional | Assault | Stranger | Self | Friend/Acq | Not Seen/Other |
|------------------|---------------|---------|----------|------|------------|----------------|
| 0 to 14          | 15-Feb        | 19-Jan  | 30-Jun   | 17-Mar| -          | 24-Jun         |
| 15 to 34         | 16-Aug        | 14-Sep  | 12-Nov   | 23-May, 22-Oct | 5-Aug | 21-Aug       |
| 35 to 54         | 8-Nov         | 4-Sep   | 12-Nov   | 7-Oct | -          | 5-Aug          |
| 55+              | 12-May, 10-Nov| 23-Aug  | 3-Oct    | 14-May, 13-Nov | 28-May | -            |

When there are 2 or more dates, then the best cosine fit was bi/multimodal.
Dates in italics are for fits with 0.05> p < 0.10.
those with unintentional injuries a peak on Feb 15 (p = 0.004). Unintentional injuries from rifles were Nov 8, shotguns Nov 14, and BB guns April 17 (rifle vs BB p = 0.004, shotgun vs BB p = 0.002). Self inflicted injuries for those 0 to 14 years of age were Feb 15, 15 to 34 years Nov 17, and 35 to 54 years Nov 8 (0 to 14 vs 15 to 34 years, p = 0.035; 0 to 14 vs 35 to 54 years, p = 0.017). Large hospitals had an overall peak on Aug 31; unintentional injuries seen at large hospitals peaked Nov 14 while assaults peaked Aug 11 (p = 0.002).

Our results can be used to assist in both allocations of resources for medical institutions caring for these injuries as well as guide prevention campaigns. Education campaigns for unintentional and self inflicted injuries can be postulated; those for assaults and injuries caused by strangers or those not seen are more difficult to postulate. For instance, public education service announcements targeting accidental injuries from BB guns could be concentrated in March, prior to the April peak. Education for hunters and users of rifles and shotguns to prevent unintentional injuries could be concentrated in the late summer. Those who live in their own homes will need reminders in the last part of the year to influence unintentional injuries. Children 5 to 9 years of age had a peak in January; parental education campaigns regarding firearm safety could be concentrated in December.

| Geographic Location | Study | p value | $r^2$ | Mesor | Amp | Date/Weekday |
|---------------------|-------|---------|-------|-------|-----|--------------|
| Monthly Data        |       |         |       |       |     |              |
| Finland             |       |         |       |       |     |              |
| All                 | 0.006 | 0.68    | 209   | 32    | 265 | 26-Sep       |
| Assault             | 0.063 | 0.46    | 52.2  | 6.7   | 33  |              |
| Self Inflicted      | 0.32  | 0.23    | 45.1  | 3.4   | 293 |              |
| Unintentional       | 0.001 | 0.78    | 91.7  | 27.6  | 266 | 27-Sep       |
| Unknown             | 0.79  | 0.05    | 19.7  | 2.1   | 302 |              |
| Los Angeles, CA     | Weaver (7) |       |       |       |     |              |
| All                 | 0.005 | 0.69    | 63.7  | 18.4  | 182 | 4-Jul        |
| African             | 0.007 | 0.67    | 41.1  | 12    | 176 | 27-Jun       |
| Hispanic            | 0.13  | 0.23    | 22.6  | 6.6   | 193 |              |
| Sweden Hunting Deaths | Junuzovic (22) | 0.095 | 0.61 | 4.75  | 5.22 | 275 | 6-Oct        |
| USA - Stray Bullets | Wintemute (6) | 0.076 | 0.44 | 23.7  | 5.9  | 189 |              |
| Iran - Head         | Tahir (8) | <0.0001 | 0.80 | 94.1  | 122.1 | 359 | 30-Dec       |
| East Baton Rouge, LA 0 to 19 yrs | Ary (1) | 0.079 | 0.43 | 38.5  | 9.3  | 153 |              |
| Weekday Data        |       |         |       |       |     |              |
| Los Angeles, CA     | Weaver (7) |       |       |       |     |              |
| All                 | 0.37  | 0.40    | 108   | 11.7  | 4   |              |
| Black               | 0.22  | 0.53    | 72.6  | 11.9  | 234 |              |
| Hispanic            | 0.01  | 0.89    | 35.3  | 21.4  | 29  | Sunday       |
| East Baton Rouge, LA 0 to 19 yrs | Ary (1) | 0.96  | 0.021 | 66.4  | 4.8  | 271 |              |
| Sweden Hunting Deaths | Junuzovic (22) | 0.13  | 0.65 | 6.7   | 3.9  | 28  |              |
| USA - Stray Bullets | Wintemute (6) | 0.46  | 0.33 | 40.4  | 5.3  | 300 |              |
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