

Demographics and Incident Location of Gunshot Wounds at a Single Level I Trauma Center

Blair Benton, MS-4¹, David Watson, MS-4¹,

Elizabeth Ablah, Ph.D., MPH², Kelly Lightwine, MPH³,

Ronda Lusk, RN³, Hayrettin Okut, Ph.D.², Thuy Bui, MPH⁴,

James M. Haan, M.D.^{1,3}

University of Kansas School of Medicine-Wichita, Wichita, KS

¹Department of Surgery

²Department of Population Health

³Ascension Via Christi Hospital on St. Francis, Department of Trauma Services, Wichita, KS

⁴University of Kansas School of Medicine-Wichita, Department of Pediatrics, Wichita, KS

Received May 29, 2020; Accepted for publication Oct. 23, 2020; Published online Feb. 12, 2021
<https://doi.org/10.17161/kjmvol14i3772>

ABSTRACT

Introduction. Kansas has seen a steady increase in the rate of firearm deaths and injuries. Little is known surrounding the demographic and geospatial factors of these firearm-related traumas. The purpose of this study was to describe the overall incidence of firearm-related traumas, identify high injury locations, and examine any racial/ethnic disparities that may exist.

Methods. A retrospective review was conducted of all patients 14 years or older who were admitted with a gunshot wound (GSW) to a Level I trauma center between 2016 and 2017.

Results. Forty-nine percent of patients were Caucasian, 26.5% African American, and 19.6% Hispanic/Latino. Hispanic/Latino patients were the youngest (25.8 ± 8.8 years) and Caucasians were the oldest (34.3 ± 14.1 years, $p = 0.002$). Compared to Caucasian patients, African American (42.0%) and Hispanic/Latino (54.1%) patients were more likely to be admitted to the intensive care unit (ICU; $p = 0.034$) and experienced longer ICU lengths of stay (2.5 ± 6.3 and 2.4 ± 4.7 days, $p = 0.031$, respectively). African American patients (96.0%) experienced more assaults, while Caucasians were more likely to receive gunshot wounds accidentally (26.9%, $p = 0.001$). More African American (86.0%) and Hispanic/Latino (89.2%) patients were injured with a handgun and Caucasians sustained the highest percentage of shotgun/rifle related injuries (16.1%, $p = 0.012$). Most GSWs occurred in zip codes 67202, 67203, 67213, 67211, and 67214. Geographical maps indicated that GSWs occur in neighborhoods with low-income and high minority residents and in the downtown and nightclub areas of the city.

Conclusions. Most GSW victims were older Caucasian males. Racial differences were noted and injury locations concentrated in certain locations. *Kans J Med* 2021;14:31-37

INTRODUCTION

Firearm-related traumas are a leading cause of morbidity and mortality in the United States (U.S.).^{1,2} Each year in the U.S., there are

approximately 67,000 nonfatal and 32,000 fatal firearm-related injuries.² Among U.S. adults aged 17 to 25 years, firearm-related injuries accounted for 80% of homicides and 45% of suicides.³ Annually, the U.S. hospital cost for treating GSWs is close to \$3 billion.⁴ In 2016, Kansas had 383 firearm-related deaths, with a mortality rate of 13.4 per 100,000.⁵ This was slightly higher than the national average of 11.8 per 100,000.⁶

Firearm ownership has been associated with an increased risk of firearm-related injury and mortality.⁷⁻⁹ Also, several studies have noted a relationship between state firearm laws and the frequency of firearm-related homicides.^{3,9-11} States with a higher number of firearm laws had 6.6 fewer firearm-related deaths per 100,000 per year than states with fewer firearm laws.⁹ States with “Stand Your Ground” laws and states with “Right to Carry” laws, like Kansas, have been shown to have an increased incidence of firearm mortality.^{3,10}

Racial disparities in firearm violence exist.^{4,12-17} Young African American males are represented disproportionately among GSW victims.¹²⁻¹⁷ In 2012, firearm violence was the leading cause of death among African American males 15 to 34 years of age.¹ Compared to Caucasian and Hispanic/Latino males, African American males have higher firearm-related homicide rates.¹² The Riddell et al. study of state firearm homicide and suicides in Black and White non-Hispanic men found that African American males had 27 more firearm-related homicides per 100,000 per year than Caucasian males.¹² On the other hand, older Caucasian males are at a higher risk for firearm-related suicides when compared to other race/ethnic groups.

National trends indicated firearm-related deaths vary by state and were more common in Southern states.^{12,12} Additional studies also suggested that injury locations are not random but occur in areas with specific demographic and socioeconomic characteristics.¹⁵⁻²¹ Differences between urban and rural firearm deaths also have been established.²²⁻²³ Since the beginning of 2015, Kansas has seen a steady increase in the rate of firearm-related traumas.²⁴ Little is known surrounding the demographic and geospatial factors of these injuries. The purpose of this study was to describe the overall incidence of firearm-related traumas, identify injury location, and examine any racial/ethnic disparities that may exist.

METHODS

Kansas is a predominantly rural state and is served by three American College of Surgeons Committee on Trauma (ACS COT)-verified Level I trauma centers. Two of these centers, Wesley Medical Center and Ascension Via Christi St. Francis, are located within Sedgwick County and are 2.3 miles apart. The dividing line for patient trauma destination is determined by Interstate 135 (I-135), which runs north-south through the city (Figure 1). Injuries east of I-135 go to Wesley Medical Center and injuries west of I-135 go to Ascension Via Christi St. Francis. Among traumas that occur outside of the county line, patient trauma destination is determined either by the responding Emergency Medical Services (EMS) or the transferring facility. However, there is some overlap of injuries due to trauma patients arriving by private vehicle and transfers from non-trauma center.

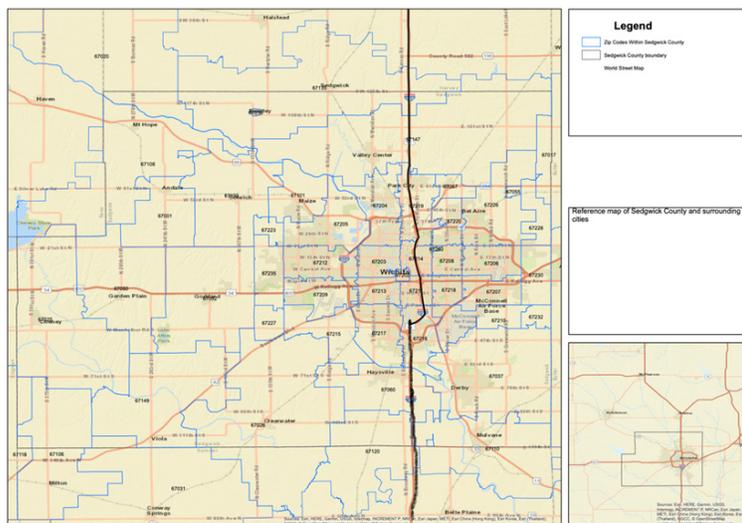


Figure 1. Sedgwick County reference map indicating I-135 dividing line for trauma patient destination.

A retrospective chart review was conducted of all patients 14 years or older who were admitted with a gunshot wound to Ascension Via Christi St. Francis from January 1, 2016 through December 31, 2017. Patients were excluded if the injury occurred outside of Kansas or if the GSW was self-inflicted. Injuries documented as “self-inflicted” include patients who intentionally harmed themselves, such as suicides and attempted suicides. This information is based on information collected at the scene of the injury and provided to hospital staff by first responders or from EMS reports.

Patient identification and data retrieval were performed using the trauma registry and electronic patient medical records. Abstracted patient data included demographics (race/ethnicity, age, gender, insurance status), injury details (mechanism of injury, Injury Severity Score [ISS], abbreviated injury severity scores [AIS], injury location [street address and zip code]), hospital parameters (intensive care unit [ICU] admission and length of stay, mechanical ventilation use and length of use, hospital length of stay), discharge destination, and mortality. The type of gun used (handgun, shotgun/rifle, unspecified) and intent surrounding the injury (assault, accidental, legal intervention, unspecified) also were abstracted from the trauma registry and patient chart.

Patient race and ethnicity are provided to the trauma department by the patient. If a patient was reported as being biracial or having two ethnicities, they were characterized by the first race/ethnicity listed in the registry. The intention surrounding the GSW was documented in the trauma registry based on information provided by EMS or the patient. If no intention was given, the injury was marked as unspecified. When a patient sustained multiple GSWs involving different body regions, they were reported as having two or more AIS.

Descriptive analyses were presented as frequencies with percentages for categorical variables and means with standard deviations for continuous variables. Before performing comparative analysis, patients were grouped by the three most predominant race/ethnicity categories (Caucasians, African American, Hispanic/Latino). Independent sample t-tests were used to explore mean differences between continuous variables, while Chi-square tests were used to assess the distributions of categorical variables.

Kernel Density Estimation (KDE) was used to create maps of GSW injury locations. KDE is a non-parametric technique for estimating the probability density function of a random variable. Using ArcGIS Desktop version 10.4.1 (ESRI, Redlands, CA), KDE was used to estimate risk zones by calculating the density of GSW injury locations around individual output raster cells as a function of the frequency and proximity of known trauma injury locations.²³

The final output is displayed as a smoothly tapered raster image. The value of the smoothly tapered surface is highest at the location of the point and diminishes with increasing distance from the point, reaching zero at the search radius distance from the point. The following equation was used to determine the search radius: $\text{Search Radius} = 0.9(\text{SD}, \sqrt{(1/\ln 2) \times D_m}) \times n^{0.2}$.

To demonstrate the socioeconomic characteristic among the population in our study area, additional maps were created using zip-code barriers and the U.S. Census Bureau 2016 American Community Survey.²⁴ These maps display the percentage of residents living below the Federal Poverty Level (FPL), and the percent of non-Hispanic Black, and Hispanic/Latino residents in our study area.²⁴

All statistical tests were two-sided, and analyses were considered significant when the result was $p \leq 0.05$. Descriptive statistics for nominal, categorical, and continuous variables were conducted by using PROC FREQ and PROC UNIVARIATE in SAS version 9.4 (SAS Int. Inc., Cary, NC). This study was approved by the Institutional Review Board at Via Christi Hospitals Wichita, Inc. and the Human Subjects Committee at the University of Kansas School of Medicine-Wichita.

RESULTS

Of the 217 patients admitted with a gunshot wound, 26 were excluded due to being intentionally self-inflicted, and two were excluded due to incident location being outside of Kansas. Among the 189 patients included, most were male (89.4%, $n = 169$) with an average age of 30.9 ± 12.9 years (Table 1). Broken down by race/ethnicity, 49.2% ($n = 93$) were Caucasians, 26.5% ($n = 50$) African American, and 19.6% ($n = 37$) Hispanic/Latino. Self-pay/charity (52.4%, $n = 99$) was the most common payment method followed by Medicare/Medicaid (24.9%, $n = 47$). A comparison of patients by race/ethnicity revealed no differences except for age. Hispanic/Latino patients comprised the youngest patients (25.8 ± 8.8 years) and Caucasians were the oldest group (34.3 ± 14.1 years, $p = 0.002$).

Patient injury severity and hospital outcomes are presented in Table 2. Twenty-three percent ($n = 44$) of all patients had an ISS > 15 with most of these injuries either being an extremity (24.9%, $n = 47$) or chest injury (21.7%, $n = 41$). Although less than half of all patients required ICU admission (37.6%, $n = 71$), 42.3% ($n = 80$) required a surgical procedure. Most patients were discharged home (72.5%, $n = 137$) and 8.5% ($n = 16$) died. Across all groups, African American (42.0%, $n = 21$) and Hispanic/Latino (54.1%, $n = 20$) patients were more likely to be admitted to the ICU ($p = 0.034$) and had longer ICU

lengths of stay (2.5 ± 6.3 and 2.4 ± 4.7 days, $p = 0.031$, respectively) than Caucasian patients. No other differences were noted between the groups.

Table 1. Demographics of patients presenting with gunshot wounds by race/ethnicity.

Parameter*	Total	Caucasian	African American	Hispanic/Latino	p value
Number of patients	189 (100%)	93 (49.2%)	50 (26.5%)	37 (19.6%)	
Gender					0.834
Male	169 (89.4%)	83 (89.3%)	44 (88.0%)	34 (91.9%)	
Female	20 (10.6%)	10 (10.8%)	6 (12.0%)	3 (8.1%)	
Average age	30.0 ± 12.9	34.3 ± 14.1	29.4 ± 12.0	25.8 ± 8.8	0.002
Age groups					0.130
14 - 19	37 (19.6%)	13 (14.0%)	11 (22.0%)	9 (24.3%)	
20 - 24	40 (21.2%)	13 (14.0%)	12 (24.0%)	13 (35.1%)	
25 - 29	29 (15.3%)	16 (17.2%)	6 (12.0%)	7 (18.9%)	
30 - 34	28 (14.8%)	16 (17.2%)	6 (12.0%)	4 (10.8%)	
35 - 39	15 (7.9%)	8 (8.6%)	6 (12.0%)	1 (2.7%)	
40+	40 (21.2%)	27 (29.0%)	9 (18.0%)	3 (8.1%)	
Insurance					0.274
Self-pay/charity	99 (52.4%)	48 (51.6%)	24 (48.0%)	20 (54.1%)	
Medicare/Medicaid	47 (24.9%)	19 (20.4%)	18 (36.0%)	8 (21.6%)	
Commercial	26 (13.8%)	15 (16.1%)	6 (12.0%)	5 (13.5%)	
Workers compensation	10 (5.3%)	8 (8.6%)	1 (2.0%)	1 (2.7%)	
Other	7 (3.7%)	3 (3.2%)	1 (2.0%)	3 (8.1%)	

Table 2. Injury severity and hospital outcomes of patients presenting with gunshot wounds by race/ethnicity.

Parameter*	Total	Caucasian	African American	Hispanic/Latino	p value
Number of patients	189 (100%)	93 (49.2%)	50 (26.5%)	37 (19.6%)	
Injury Severity Score > 15	44 (23.3%)	19 (20.4%)	13 (26.0%)	11 (29.7%)	0.493
Abbreviated Injury Severity Score ≥ 3					
Head	9 (4.8%)	3 (3.2%)	5 (10.0%)	1 (2.7%)	0.230
Chest	41 (21.7%)	18 (19.4%)	10 (20.0%)	11 (29.7%)	0.335
Abdominal	22 (11.6%)	8 (8.6%)	6 (12.0%)	6 (16.2%)	0.337
Extremity	47 (24.9%)	20 (21.5%)	11 (22.0%)	12 (32.4%)	0.889
Two or more AIS scores	46 (24.3%)	17 (18.3%)	15 (30.0%)	11 (29.7%)	0.188
ICU admit	71 (37.6%)	28 (30.1%)	21 (42.0%)	20 (54.1%)	0.034
ICU length of stay (days)	1.9 ± 4.9	1.6 ± 4.3	2.5 ± 6.3	2.4 ± 4.7	0.031
Mechanical ventilation	39 (20.6%)	16 (17.2%)	11 (22.0%)	10 (27.0%)	0.446
Mechanical ventilation (days)	1.1 ± 3.9	0.8 ± 2.9	1.6 ± 5.6	1.4 ± 3.9	0.262
Surgery	80 (42.3%)	38 (40.9%)	21 (42.0%)	17 (45.9%)	0.960
Hospital length of stay (days)	4.5 ± 7.6	4.2 ± 6.5	5.1 ± 10.5	5.0 ± 6.5	
Disposition					0.225
Home/home with care	137 (72.5%)	66 (71.0%)	36 (72.0%)	26 (70.3%)	
Left AMA/Jail	16 (8.5%)	9 (9.7%)	5 (10.0%)	2 (5.4%)	
Rehabilitation	13 (6.9%)	6 (6.5%)	2 (4.0%)	5 (13.5%)	
Skilled nursing	7 (3.7%)	6 (6.5%)	1 (2.0%)	0 (0.0%)	
Mortality	16 (8.5%)	6 (6.5%)	6 (12.0%)	4 (10.8%)	0.484

*Values presented as n (%) or mean \pm standard deviation.

Differences were noted between race/ethnic groups concerning the intent and type of gun used (Table 3). Among African American patients, 96.0% (n = 48) were reported as assault-related GSWs, while Caucasians sustained the most reported accidental GSWs (26.9%, n = 25, p = 0.001). Handguns were the most commonly used weapon of choice among all races, however, more African American (86.0%, n = 43) and Hispanic/Latino (89.2%, n = 33) patients were injured with a handgun than Caucasians (72.0%, n = 67, p = 0.012). Compared with the other race/ethnic groups, Caucasians experienced the highest percentage of shotgun/rifle injuries (16.1%, n = 15). No differences were noted regarding race and positive alcohol and drug tests.

Figure 2 displays the map of GSW locations for only those patients with a known incident location (70.4%, n = 133). Colors corresponded to density of cases per square mile, with red representing the highest and white the lowest. GSW incidents were concentrated in the downtown area of the study city and located southwest of the hospital. Most GSWs occurred in zip codes 67202, 67203, 67213, 67211, and 67214.

Additional maps using U.S. Census demographic data display the neighborhood characteristics for our study area population (Figures 3, 4, and 5). Figure 3 displays the percentage of area residents living below the federal poverty level (FPL). The percentage of non-Hispanic Black residents and the percentage of Hispanic/Latino residents are displayed in Figures 4 and 5, respectively. Zip code 67214 had one of the highest percentages of residents below the FPL and had a higher percentage of non-Hispanic Black, and Hispanic/Latino residents. This same zip code also corresponds to one of the highest incidents of GSWs among our trauma patients.

DISCUSSION

National and single-site GSW studies noted that the distribution of gunshot wounds is not equal regarding age, gender, and race/ethnicity.^{4,12-17} Most of these studies demonstrated that GSWs occur predominately among males, African Americans, and among those less than 30 years of age.^{4,12-17} Our study findings were similar in that most of our patients were male and were predominately 35 years of age and

under. However, our findings were not consistent when considering race. In our study, most GSW victims were Caucasian and not African American as other studies indicated.^{4,12-17}

One possibility for this discrepancy in study findings could be related to study location and difference between rural vs. an urban landscape, as our hospital serves both rural and urban populations.^{22,23} In addition, in our study, Hispanic/Latinos represent 13% of the surrounding population and African Americans 11%.²⁴ Compared to other studies, our percentage of resident African Americans was lower.^{13,16,17} For example, a GSW study conducted at a Tennessee Level I trauma center noted their city population of African Americans at 27.9% for Nashville Davidson County and 16.9% for Tennessee residents.¹³

Racial differences were noted among our GSW trauma patients. In the current study, African Americans were younger than Caucasian patients, which was in agreement with previous findings.¹²⁻¹⁷ However, Hispanic/Latinos GSW victims were the youngest age group overall. The current study also suggested racial differences in clinical outcomes, despite injury severity being similar. For instance, Hispanic/Latinos and African Americans were more likely to be admitted to the ICU and had longer ICU lengths of stay than Caucasian patients. Similar results were found by Zebib and colleagues which suggested that Hispanic/Latino and African American patients were more likely to be admitted to the ICU and experienced longer ICU lengths of stay than Caucasian patients.¹⁷ In their study, African American patients also experienced a significantly higher number of multiple gunshot wounds compared to White patients (42% vs. 35.2%, p = 0.019), which could be one of the reasons for the longer ICU length of stay. In our study, both African American and Hispanic patients also experienced a higher number of multiple gunshot wounds, however, our results were not statistically significant.

Table 3. Gunshot wound details of patients presenting with gunshot wounds by race/ethnicity.

Parameter*	Total	Caucasian	African American	Hispanic/Latino	p value
Number of patients	189 (100%)	93 (49.2%)	50 (26.5%)	37 (19.6%)	
Intent					0.001
Assault	150 (79.4%)	66 (70.9%)	48 (96.0%)	28 (75.7%)	
Accidental	32 (16.9%)	25 (26.9%)	1 (2.0%)	5 (13.5%)	
Legal intervention	4 (2.1%)	1 (1.1%)	0 (0.0%)	3 (8.1%)	
Unspecified	3 (1.6%)	1 (1.1%)	1 (2.0%)	1 (2.7%)	
Type of gun					0.012
Handgun	148 (78.3%)	67 (72.0%)	43 (86.0%)	33 (89.2%)	
Unspecified	23 (12.2%)	11 (11.8%)	6 (12.0%)	2 (5.4%)	
Shotgun/rifle	18 (9.5%)	15 (16.1%)	1 (2.0%)	2 (5.4%)	
Alcohol test, yes	148 (78.3%)	74 (79.6%)	40 (80.0%)	27 (73.0%)	0.851
Blood alcohol above legal limit (≥ 0.08), yes	30 (15.9%)	13 (14.0%)	8 (16.0%)	7 (18.9%)	0.926
Drug test, yes	7 (3.7%)	3 (3.2%)	1 (2.0%)	2 (5.4%)	0.542
Drug test positive, yes	6 (3.2%)	3 (3.2%)	1 (2.0%)	1 (2.7%)	0.583

*Values presented as n (%) or mean ± standard deviation.

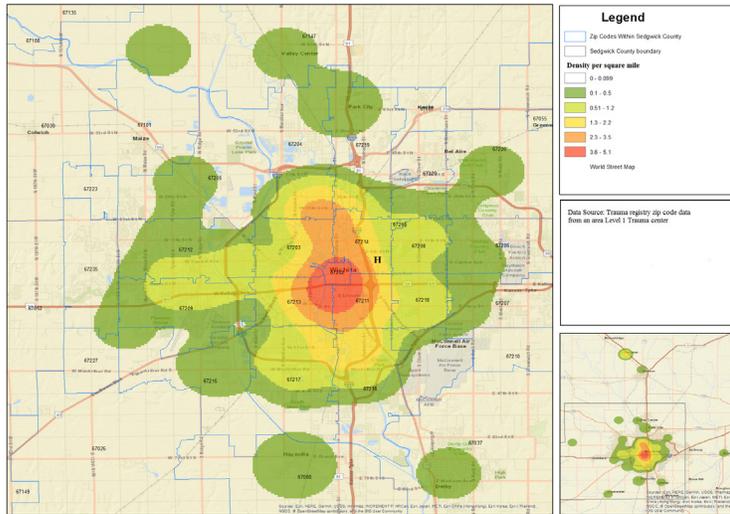


Figure 2. Geographic distribution of gunshot wounds by incident zip code between January 2016 and December 2017.

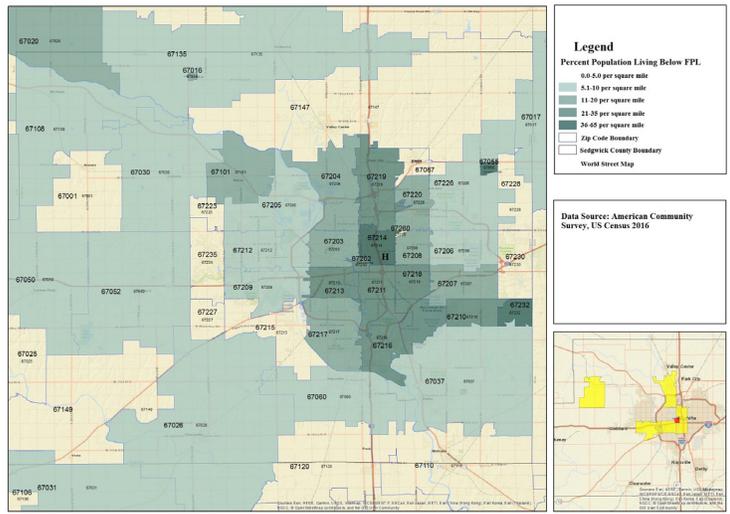


Figure 3. Residents within our study area living below the federal poverty line (FPL) displayed by zip code.

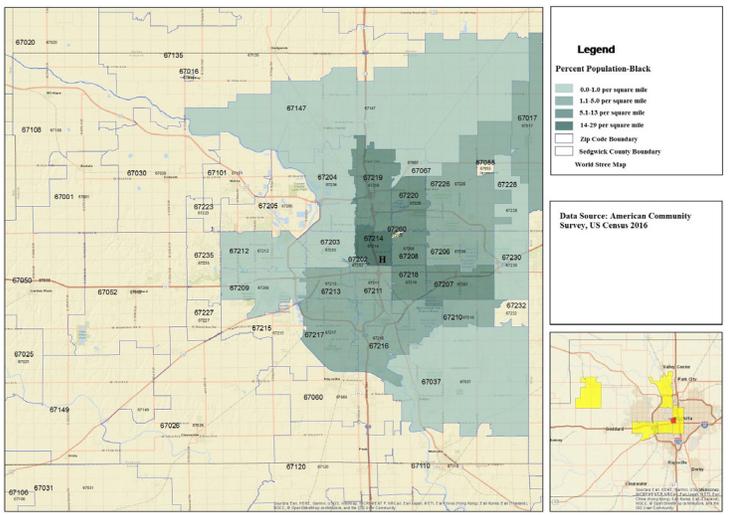


Figure 4. Non-Hispanic Black residents within our study area displayed by zip code.

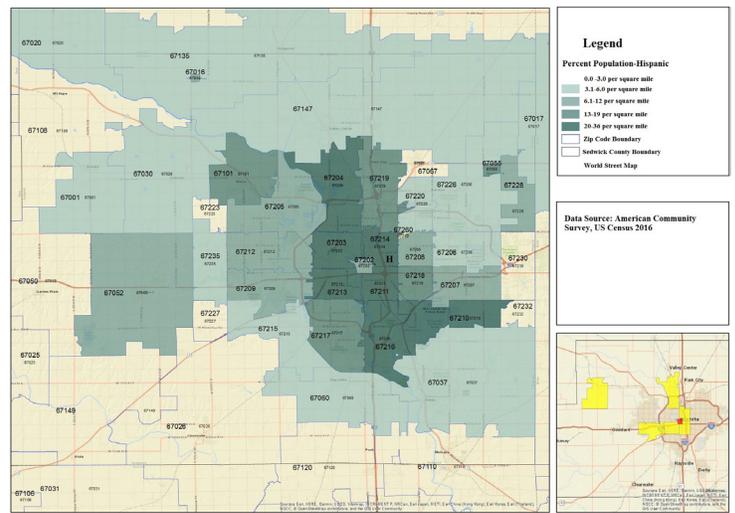


Figure 5. Hispanic/Latino residents within our study area displayed by zip code.

Consistent with other findings, the current study found African American patients were the most likely to report assaults-related GSWs, while Caucasian patients accounted for the most accidental injuries.^{4,13,15,23} Moore's study of emergency room GSW visits in middle Tennessee found that 65.9% of African Americans were injured due to assault (vs. 42.5% non-Black, $p < 0.001$), and 40.2% of non-Black patients were injured unintentionally (vs. 28.2% Black, $p < 0.001$).¹³ Similarly, police data on firearm violence in Philadelphia suggested that the relative risk of firearm assaults was 15.8 times higher (95% CI = 10.7, 23.2) among Black residents when compared to White residents.¹⁵

The study from Geutschow et al.²³ provided a similar look at gun-related injuries at a Midwest Level I trauma center. In this study, patient demographics were similar to ours in that most patients were Caucasian (74%). Additional findings suggested that the majority of their GSWs were assault related (83%) and involved a handgun (48%). With regard to circumstance surrounding the GSW, Geutschow and colleagues found similar results to ours in that Caucasians accounted for the most (84%) unintentional injuries and that African Americans accounted for most assault-related GSW (46%).²³ The most interesting finding was that 26% of unintentional injuries were related to hunting activities and 71% of hunting injuries involved a shotgun.

Violent injury locations have been shown to vary and concentrate in specific locations defined by certain features of the built environment or socioeconomic characteristics.¹⁵⁻²¹ Walker et al.²¹ demonstrated that violent trauma hotspots were most prevalent in a nightclub district with a high number of alcohol-serving establishments. Our study had consistent findings with Walker et al.²¹ in that the zip codes with the most concentrated GSW incidents included the downtown and nightclub areas of the city. We were unable to perform block-level analysis with our software to determine if the incidents occurring in these locations involved individuals living nearby.

Another study, using the home addresses of the GSW victims, noted GSW incidence rates were higher in census tracts with more Black residents ($p < 0.001$), percent single-family homes ($p < 0.001$), and median age ($p < 0.001$).¹⁷ We found similar results, using incident location, with most GSWs occurring in zip codes that correspond to areas with a higher percentage of residents living below the FPL and a higher percentage of non-Hispanic Black and Hispanic/Latino residents. Due to

unknown home addresses of some patients in the study, it was unclear whether the shootings in our study that occurred in a specific zip code involved the individuals that lived there or people from outside the zip code. Several studies have, however, demonstrated that violent injuries occur close to a victim's place of residence.^{16,17,19}

Further research is needed to address why, despite excluding self-inflicted GSWs, older Caucasian males comprised most of our GSW study population. Determining what causes high incidents of GSW in certain zip codes also needs to be addressed. A full community approach among law enforcement, local charities, and community advocates would be beneficial. Efforts to collaborate with both Level I trauma centers also are needed to establish the trends of the GSW population better. Gun violence and injury prevention programs must evaluate their target audiences, potentially increasing focus on older Caucasian males and zip codes with higher incidents of GSW.

This study was subject to several limitations. First, the number of GSWs that occurred in Sedgwick County during our study period were underrepresented in the findings since shooting victims who died at the scene and those who were transferred to the other local trauma center were excluded. In addition, our results included patients that were only in the trauma registry. Patients that sustained GSWs distal to the wrist or ankle were not included in the registry, thus resulting in an underestimation of the GSWs during the study period. Second, an issue existed due to missing data in the registry and patients' charts. We were unable to give more detailed information regarding the circumstance of the injury, such as a hunting accident or that the shooting occurred during a crime. Information regarding the patient such as whether they had a concealed carry license, if they had a gun in the home, or if they took a gun safety course was also not available. Relying on self-reported data from the patient regarding injury intent was a limitation. This could have resulted in misclassification of the intent of the injury and skewing results. We would have benefited from following up with police regarding the nature of the GSWs, but due to the emergent nature of traumatic injuries, this was not done. Lastly, using aggregated population data, such as Census data, to describe individuals was a limitation. We cannot say with certainty that residents living in areas with a high concentration of shootings were the ones doing the shooting or if individuals from outside the neighborhoods were involved.

CONCLUSIONS

It is well established that the distribution of gunshot wounds is not equal regarding age, gender, and race/ethnicity. Newer studies, using GIS, have demonstrated that where gunshot wounds occur may not be random. The purpose of the current study was to describe the overall incidence of firearm-related traumas and examine any racial/ethnic disparities at a Midwest Level I trauma center. Study findings were consistent with national gun-violence trends concerning patient age and gender. However, the results suggested that among our study population most gunshot wounds were sustained by older Caucasian males. Additional findings demonstrated that GSWs were concentrated in the downtown area of the study city and corresponded with areas of lower socioeconomic status and higher percentage of minority residents.

ACKNOWLEDGMENTS

This project was supported by Dean's Level I Grant Award, University of Kansas School of Medicine-Wichita.

REFERENCES

- Wintemute GJ. The epidemiology of firearm violence in the twenty-first century United States. *Annu Rev Public Health* 2015; 36:5-19. PMID: 25533263.
- Fowler KA, Dahlberg LL, Haileyesus T, Annett JL. Firearm injuries in the United States. *Prev Med* 2015; 79:5-14. PMID: 26116133.
- Kalesan B, Mobily ME, Keiser O, Fagan JA, Galea S. Firearm legislation and firearm mortality in the USA: A cross-sectional, state-level study. *Lancet* 2016; 387(10030):1847-1855. PMID: 26972843.
- Cook A, Osler T, Hosmer D, et al. Gunshot wounds resulting in hospitalization in the United States: 2004-2013. *Injury* 2017; 48(3):621-627. PMID: 28173921.
- US Centers for Disease Control and Prevention. Stats of the State of Kansas. 2016. <https://www.cdc.gov/nchs/pressroom/states/kansas/kansas.htm>. Accessed November 19, 2019.
- US Centers for Disease Control and Prevention. Web-based Injury Statistics Query and Reporting System (WISQARS). <https://www.cdc.gov/injury/wisqars/nonfatal.html>. Accessed November 19, 2019.
- Siegel M, Ross CS, King C 3rd. The relationship between gun ownership and firearm homicide rates in the United States, 1981-2010. *Am J Public Health* 2013; 103(11):2098-2105. PMID: 24028252.
- Monuteaux MC, Lee LK, Hemenway D, Mannix RC, Fleegler EW. Firearm ownership and violent crime in the U.S.: An ecologic study. *Am J Prev Med* 2015; 49(2):207-214. PMID: 26091930.
- Fleegler EW, Lee LK, Monuteaux MC, Hemenway D, Mannix R. Firearm legislation and firearm-related fatalities in the United States. *JAMA Intern Med* 2013; 173(9):732-740. PMID: 23467753.
- Crifasi CK, Merrill-Francis M, McCourt A, Vernick JS, Wintemute GJ, Webster DW. Association between firearm laws and homicide in urban. *J Urban Health* 2018; 95(3):383-390. PMID: 29785569.
- Kaufman EJ, Morrison CN, Branas CC, Wiebe DJ. State firearm laws and interstate firearm deaths from homicide and suicide in the United States: A cross-sectional analysis of data by county. *JAMA Intern Med* 2018; 178(5):692-700. PMID: 29507953.
- Riddell CA, Harper S, Cerdá M, Kaufman JS. Comparison of rates of firearm and nonfirearm homicide and suicide in black and white non-Hispanic men by U.S. state. *Ann Intern Med* 2018; 168(10):712-720. PMID: 29710093.
- Moore DC, Yoneda ZT, Powell M, et al. Gunshot victims at a major level I trauma center: A study of 343,866 emergency department visits. *J Emerg Med* 2013; 44(3):585-591. PMID: 22995579.
- Manley NR, Fabian TC, Sharpe JP, Magnotti LJ, Croce MA. Good news, bad news: An analysis of 11,294 gunshot wounds (GSWs) over two decades in a single center. *J Trauma Acute Care Surg* 2018; 84(1):58-65. PMID: 28697020.
- Beard JH, Morrison CN, Jacoby SE, et al. Quantifying disparities in urban firearm violence by race and place in Philadelphia, Pennsylvania: A cartographic study. *Am J Public Health* 2017; 107(3):371-373. PMID: 28103077.
- Livingston DH, Lavery RF, Lopreiato MC, Lavery DF, Passannante MR. Unrelenting violence: An analysis of 6,322 gunshot wound patients at a Level I trauma center. *J Trauma Acute Care Surg* 2014; 76(1):2-9; discussion 9-11. PMID: 24368351.
- Zebib L, Stoler J, Zakrisson TL. Geo-demographics of gunshot wound injuries in Miami-Dade county, 2002-2012. *BMC Public Health* 2017; 17(1):174. PMID: 28178967.
- Lasecki CH, Mujica FC, Stutsman S, et al. Geospatial mapping can be used to identify geographic areas and social factors associated with intentional injury as targets for prevention efforts distinct to a given community. *J Trauma Acute Care Surg* 2018; 84(1):70-74. PMID: 29040200.
- Newgard CD, Sanchez BJ, Bulger EM, et al. A geospatial analysis of severe firearm injuries compared to other injury mechanisms: Event characteristics, location, timing, and outcomes. *Acad Emerg Med* 2016; 23(5):554-565. PMID: 26836571.

²⁰ Cusimano M, Marshall S, Rinner C, Jiang D, Chipman M. Patterns of urban violent injury: A spatio-temporal analysis. PLoS One 2010; 5(1):e8669. PMID: 20084271.

²¹ Walker BB, Schuurman N, Hameed SM. A GIS-based spatiotemporal analysis of violent trauma hotspots in Vancouver, Canada: Identification, contextualisation and intervention. BMJ Open 2014; 4(2):e003642. PMID: 24556240.

²² Carr BG, Nance ML, Branas CC, et al. Unintentional firearm death across the urban-rural landscape in the United States. J Trauma Acute Care Surg 2012; 73(4):1006-1010. PMID: 22976424.

²³ Guetschow B, Lilienthal M, Willey M. Unintentional firearm injuries remain prevalent over a 12 year experience at a rural midwestern level 1 trauma center. Iowa Orthop J 2018; 38:45-52. PMID: 30104924.

²⁴ United States Census Bureau. American Community Survey. 2016. <https://www.census.gov/acs/www/data/data-tables-and-tools/data-profiles/2016/>. Accessed September 19, 2018.

Keywords: gunshot wounds, racial factors, geographic information systems, geographic mapping