

The Occurrence of Traffic Injuries in Denver with a Focus on Geographic Location, 9/1/2011-8/31/2016

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Background

This technical report was prepared in response to a request made to Denver Public Health on 9/1/2016 and later amended on 9/18/2016 and 11/3/2016.

Michele Shimomura, a manager in Denver Environmental Health's Community Health Division, requested information to help guide Denver's efforts to prevent transportation-related injuries. The ultimate goal of the request is to identify high priority areas for traffic injury prevention in the City and County of Denver in accordance with the Denver Vision Zero initiative.

The data summarized in this report were collected by Denver Health Paramedic Division personnel as they responded to incidents in the field. An incident's geographic location was assigned by the 911 call center. EMS trip reports are typically completed within 24 hours. Denver Health's paramedics collected the data using an electronic data collection and management software developed by High Plains Information Systems, Inc. All data are collected at the level of the *patient*, rather than the *incident*.

The maps in the report include five years of data (9/1/2011-8/31/2016). The other statistical summaries include four full calendar years of data (1/1/2012-12/31/2015) for ease of presentation. All paramedic transports from locations outside Denver County were excluded from this report, as were incidents that occurred on interstate highways I-25, I-70 and I-225.

Per the request, the following variables are especially important to the Coalition's efforts:

- Location
- Crash Type
- Injury Severity
- Time of Day

This report is descriptive in nature. Additional statistical analyses could assess how various factors, including chance, might have influenced the injury patterns presented here. Also, note that the scales of certain figures (see notes at bottom of select pages) have been adjusted to compare patterns of injury across types that have an order of magnitude differences in frequencies. Additional technical notes are included at the end of this document.

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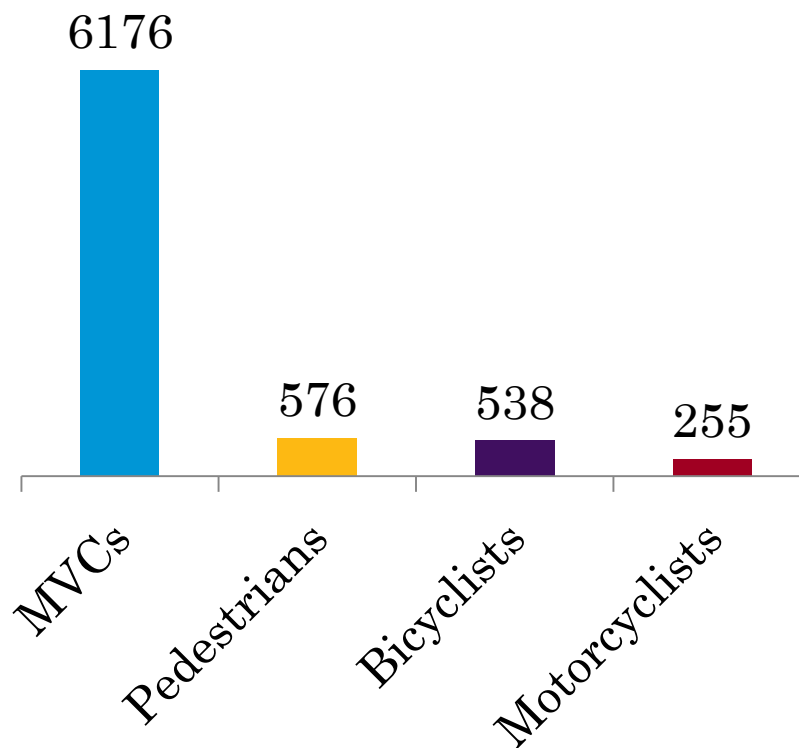
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OVERVIEW: TRAFFIC INJURIES IN DENVER 1/1/12-12/31/15

Motor vehicle crashes (MVCs) are the most common type of traffic injury in Denver. But each year, hundreds of pedestrians, bicyclists and motorcyclists are treated by Denver Health paramedics for injuries they sustained in traffic, as well.

Traffic injuries represent approximately 31% of all paramedic encounters. Also, approximately 26% of ambulance transports are due to traffic injuries.

Number of Traffic Injuries During 2015

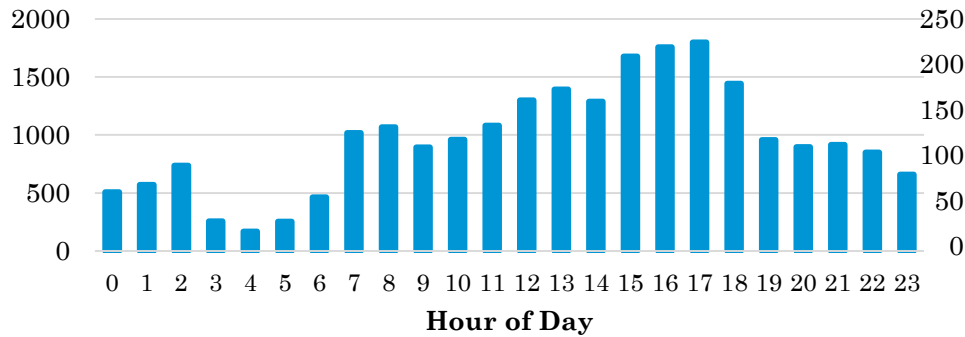


OVERVIEW: TRAFFIC INJURIES IN DENVER 1/1/12-12/31/15

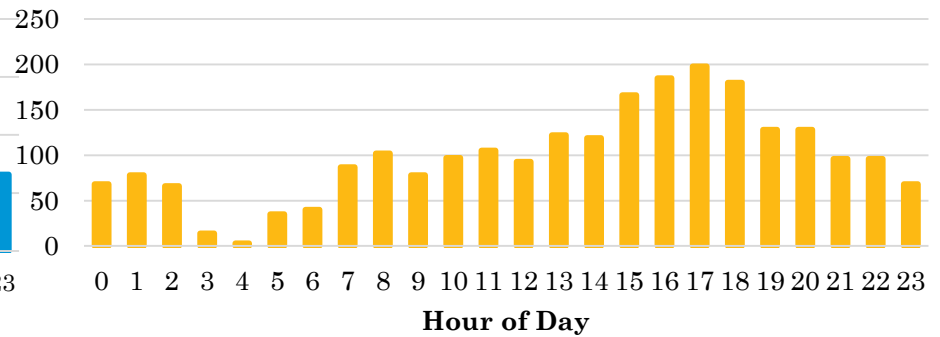


The numbers of traffic injuries vary by the time of day...

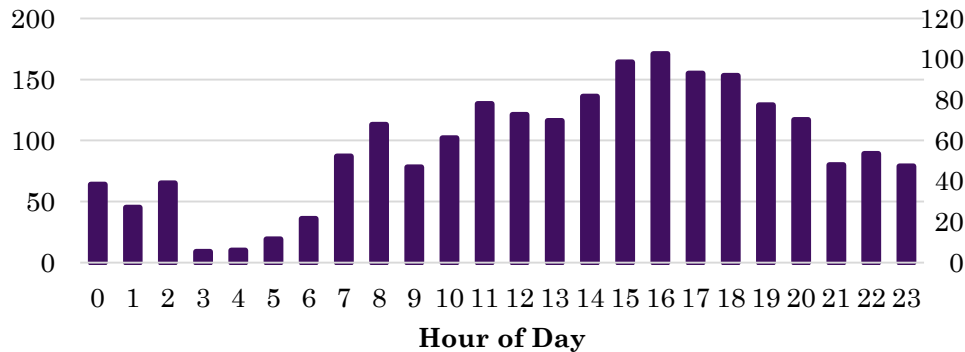
MVC Patients



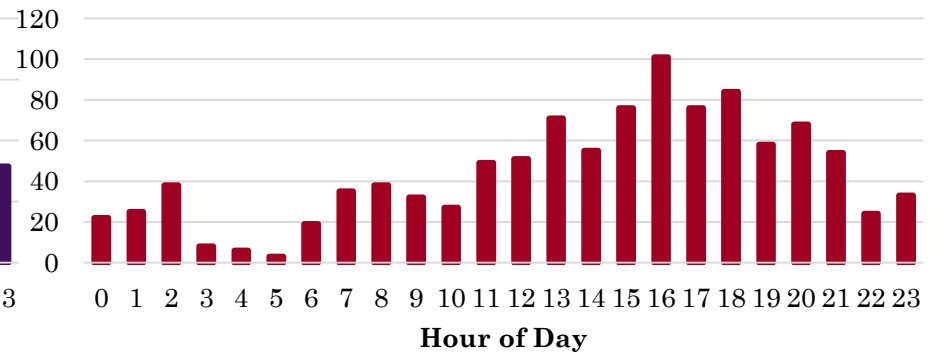
Pedestrians



Bicyclists



Motorcyclists

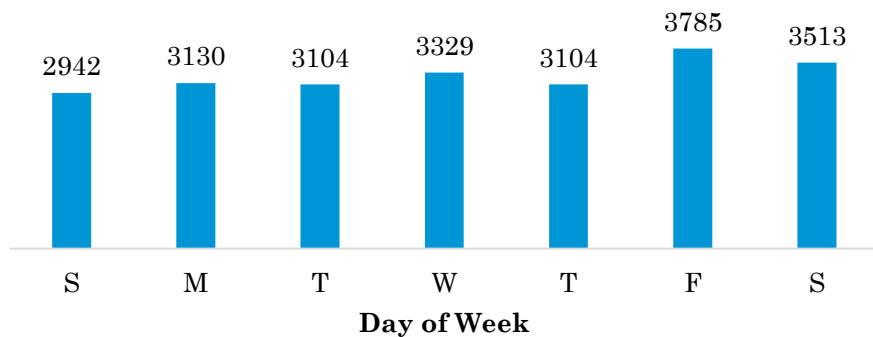


Note: Vertical axis scales are not equal.

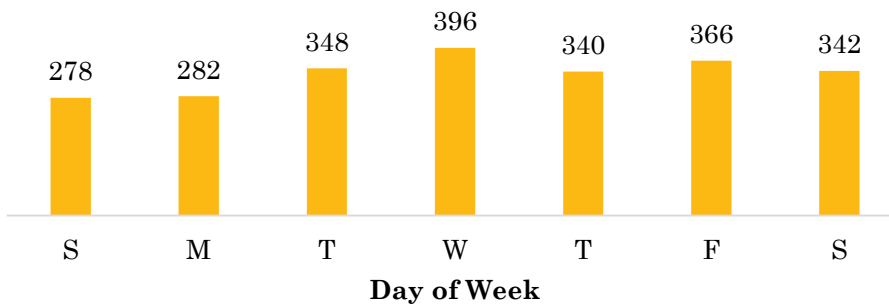
OVERVIEW: TRAFFIC INJURIES IN DENVER 1/1/12-12/31/15

the day of the week...

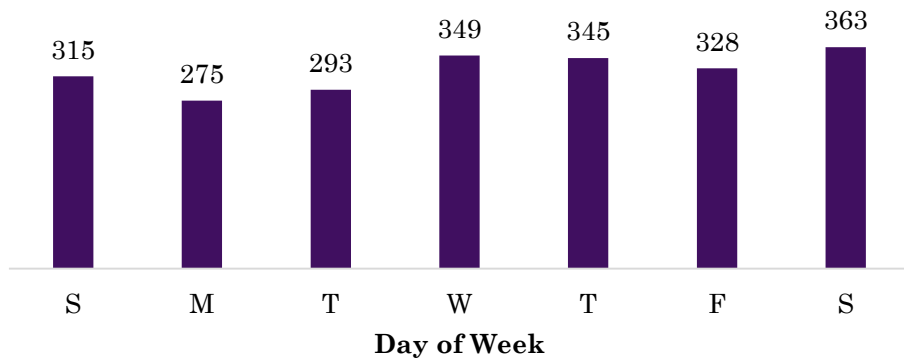
MVC Patients



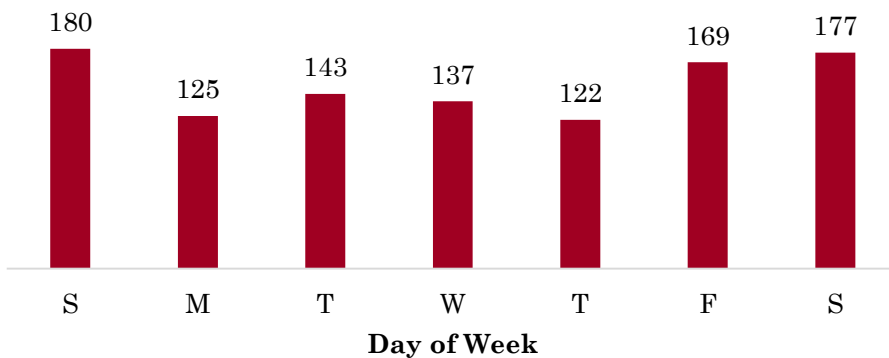
Pedestrians



Bicyclists



Motorcyclists

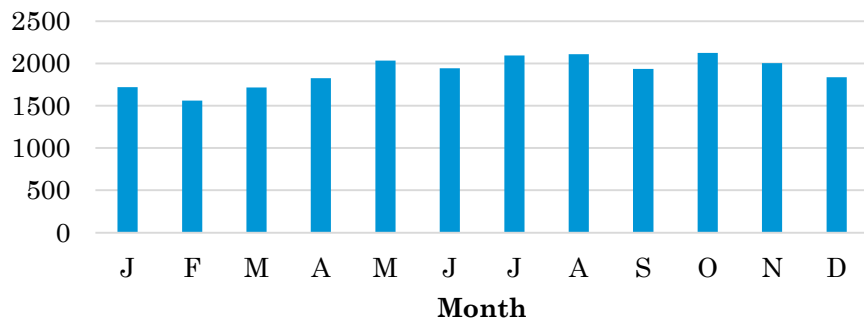


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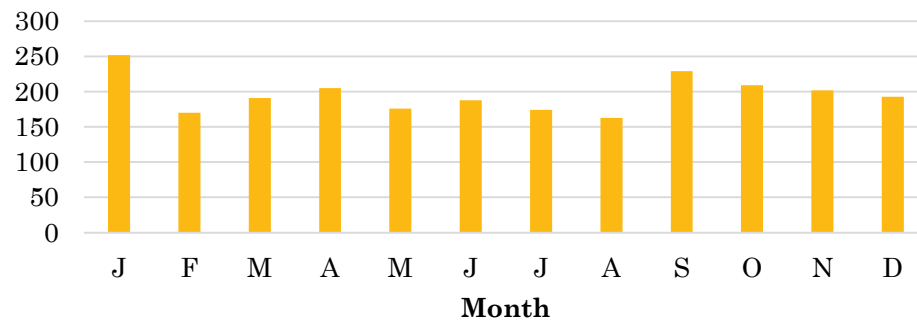
OVERVIEW: TRAFFIC INJURIES IN DENVER 1/12-12/31/15

the month...

MVC Patients



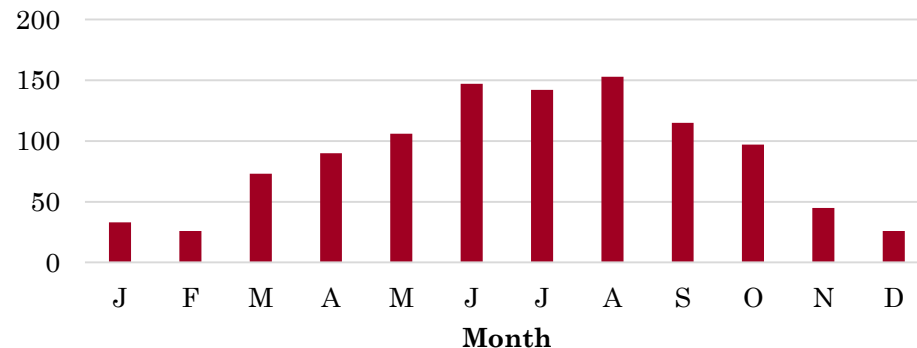
Pedestrians



Bicyclists



Motorcyclists

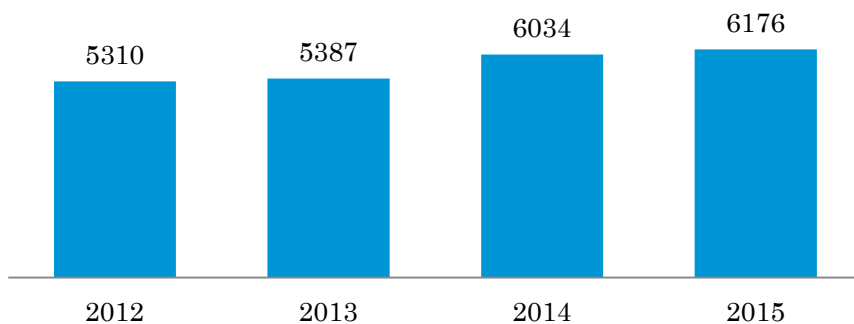


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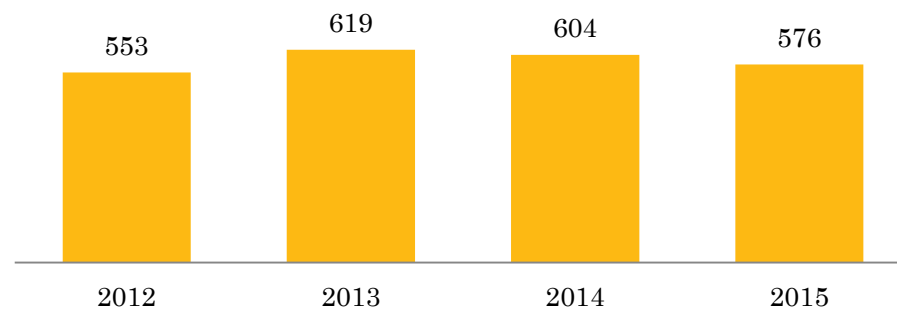
OVERVIEW: TRAFFIC INJURIES IN DENVER 1/1/12-12/31/15

the year...

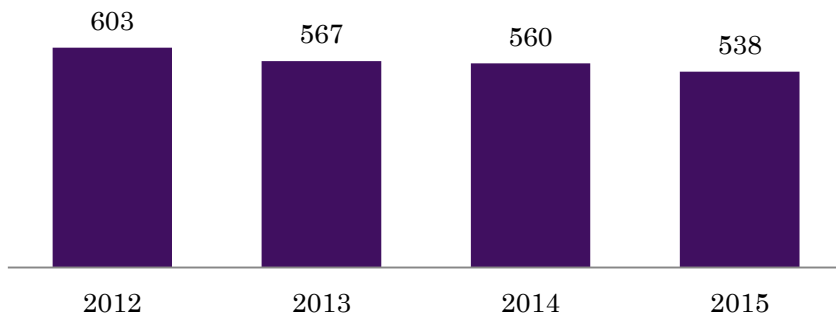
MVC Patients



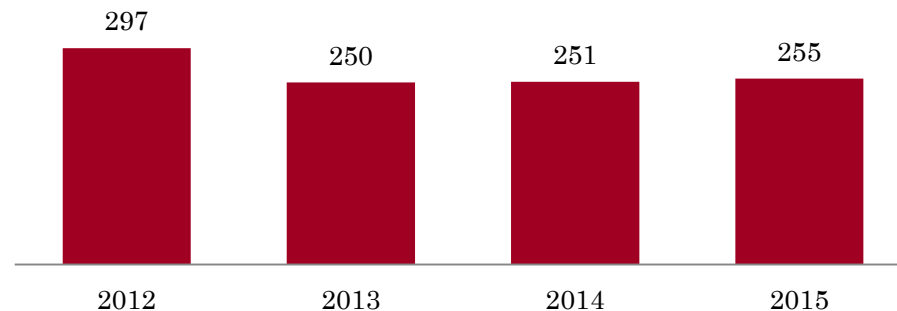
Pedestrians



Bicyclists



Motorcyclists

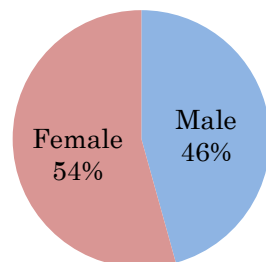


Note: Vertical axis scales are not equal.

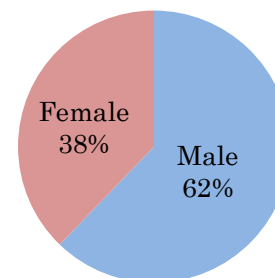
OVERVIEW: TRAFFIC INJURIES IN DENVER 1/1/12-12/31/15

the patient's gender...

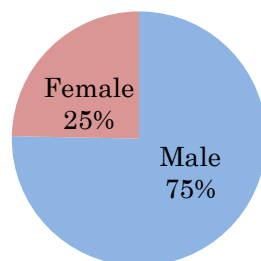
MVC Patients



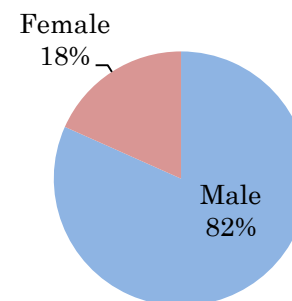
Pedestrians



Bicyclists



Motorcyclists

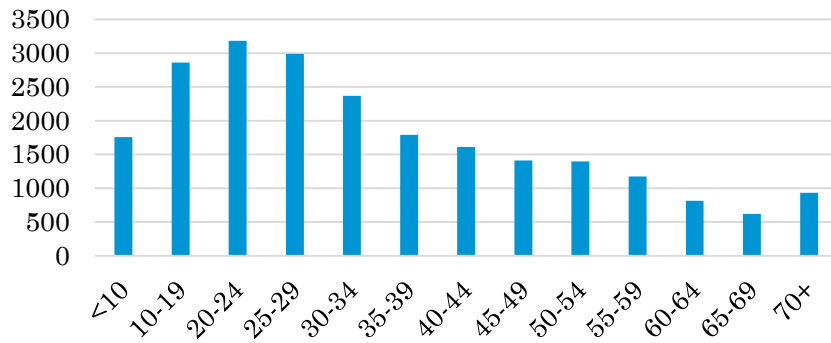


OVERVIEW: TRAFFIC INJURIES IN DENVER 1/1/12-12/31/15

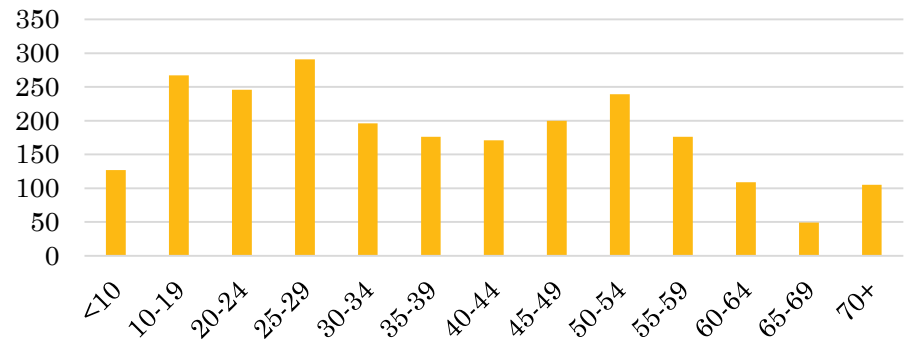


and his or her age.

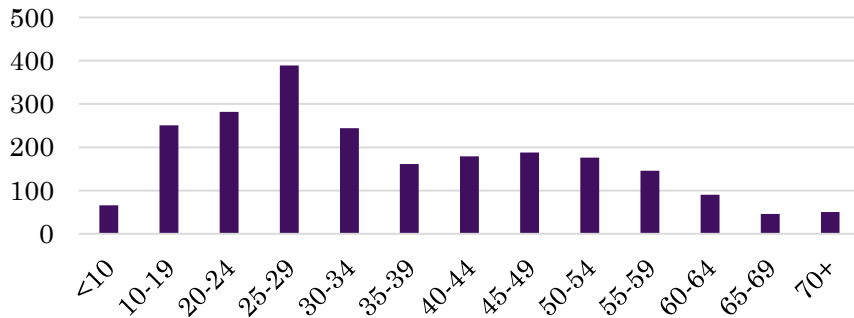
MVC Patients



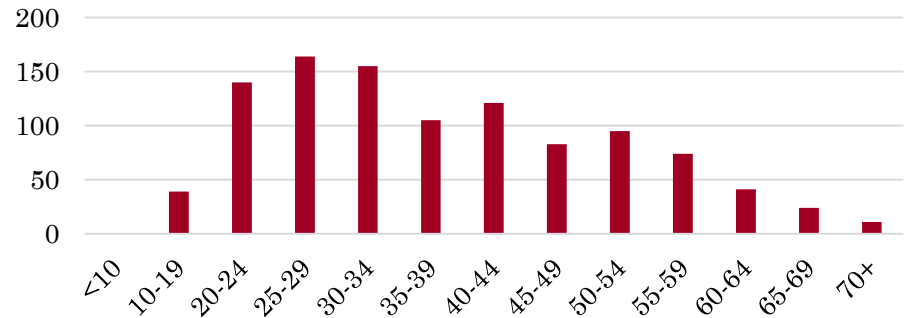
Pedestrians



Bicyclists



Motorcyclists



Note: Vertical axis scales are not equal.
Number of years in a given age range vary.

OVERVIEW: TRAFFIC INJURIES IN DENVER 1/1/12-12/31/15

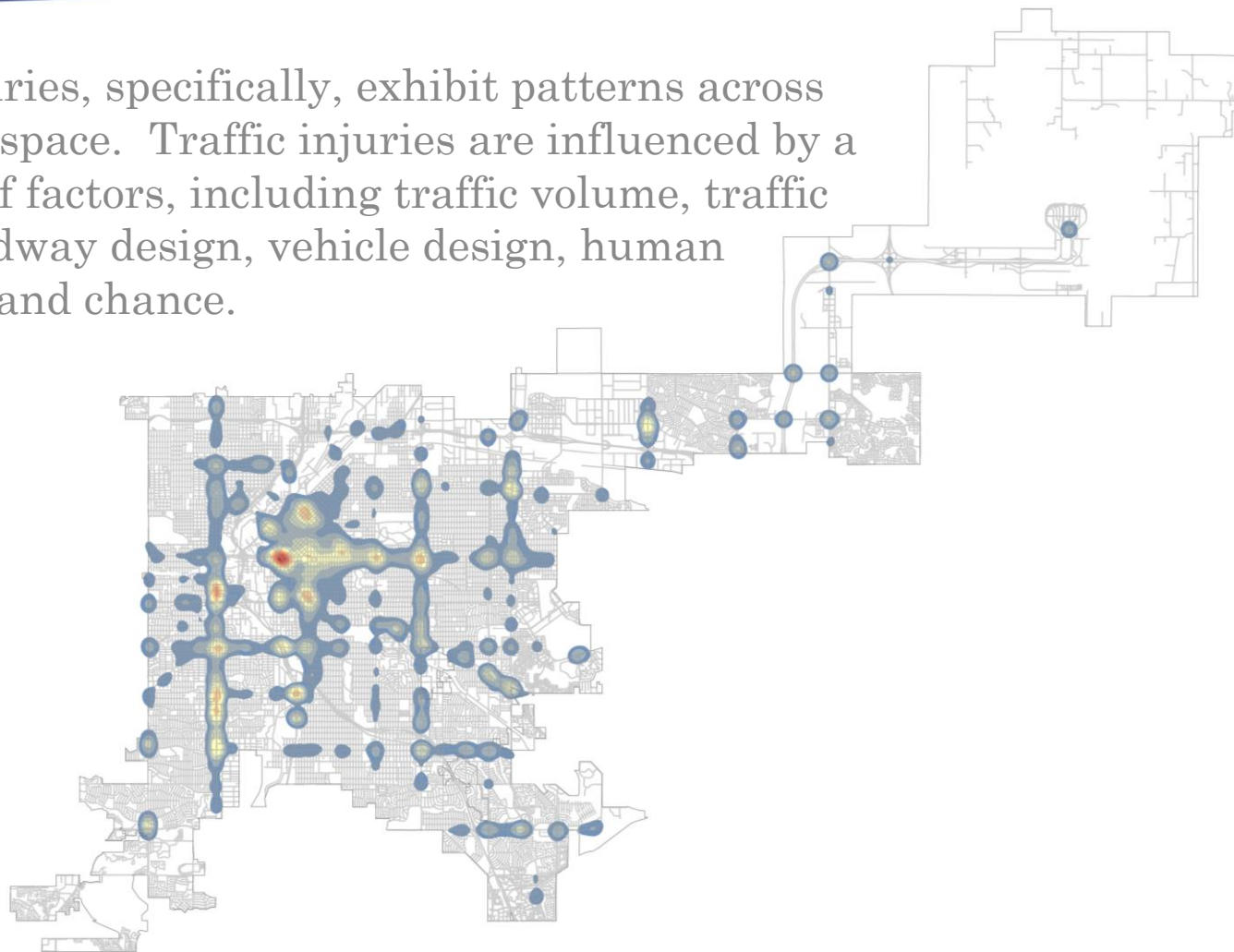
Geography plays an important role in the occurrence of traffic injuries. The speed limit varies from place to place. Protective barriers, dedicated bike lanes, crosswalks and other safety features exist in some locations, but not in others. Neighborhoods with high concentrations of bars might also have more drunk drivers. By analyzing where traffic injuries occur, city leaders can identify areas where engineering and administrative measures might prevent future injuries and save lives.



MOTOR VEHICLE CRASHES

MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

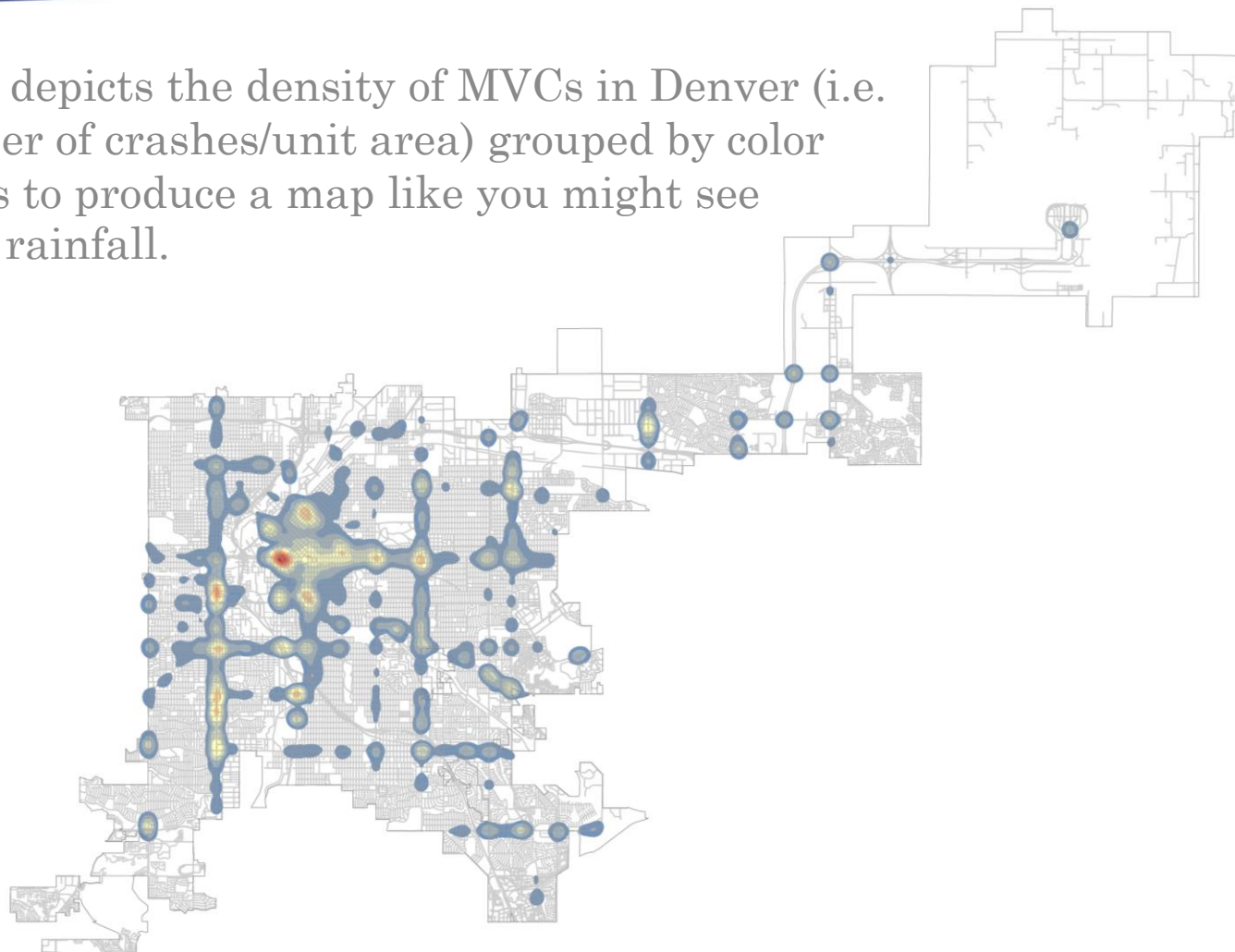
MVC injuries, specifically, exhibit patterns across time and space. Traffic injuries are influenced by a number of factors, including traffic volume, traffic laws, roadway design, vehicle design, human behavior and chance.



Note: Map not directly comparable to maps of other injury types.

MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

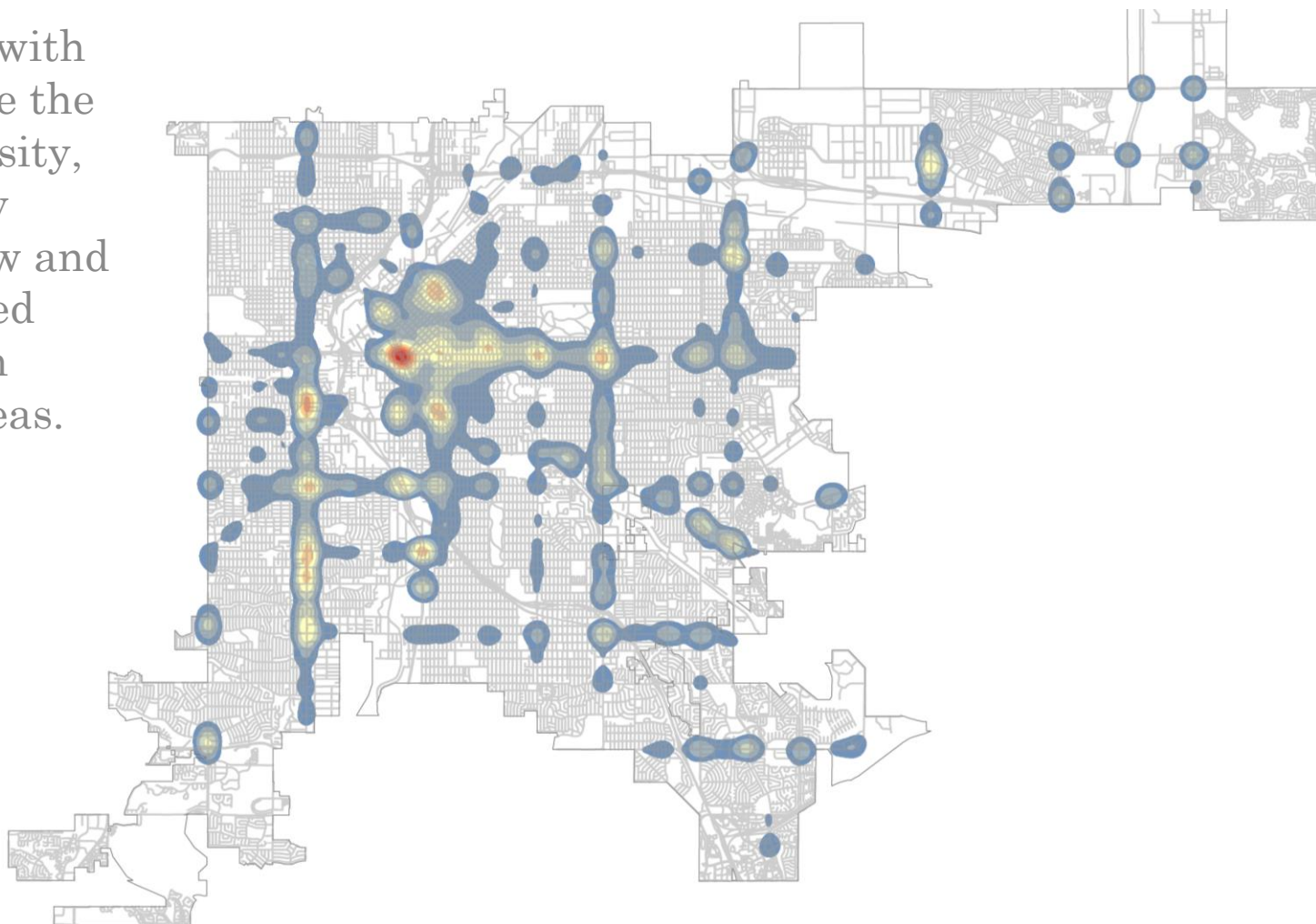
This map depicts the density of MVCs in Denver (i.e. the number of crashes/unit area) grouped by color categories to produce a map like you might see depicting rainfall.



Note: Map not directly comparable to maps of other injury types.

MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

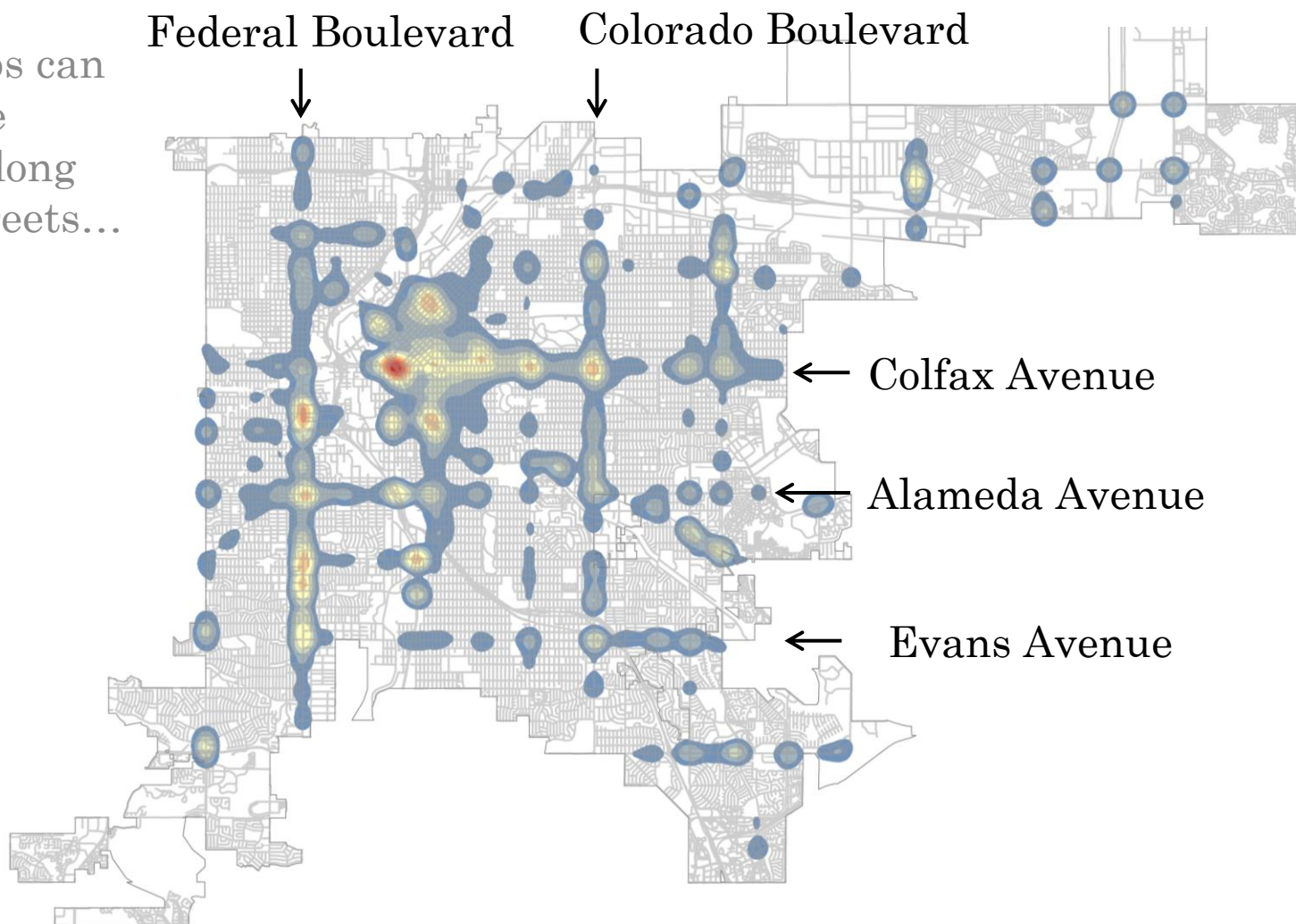
The areas with no color are the lowest density, followed by blue, yellow and orange. Red shows high density areas.



Note: Map not directly comparable to maps of other injury types.

MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

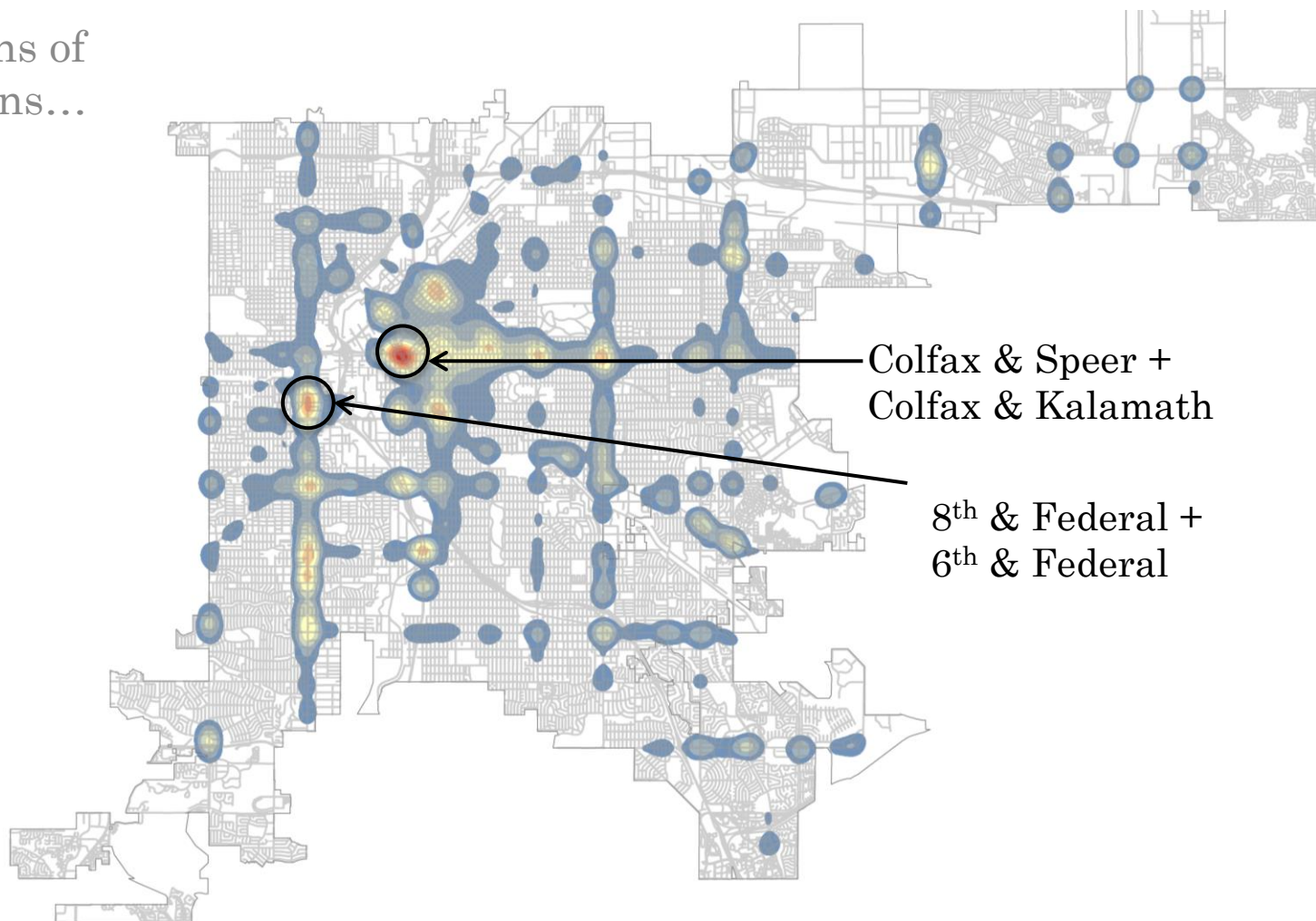
These maps can help us see patterns along specific streets...



Note: Map not directly comparable to maps of other injury types.

MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

...collections of intersections...

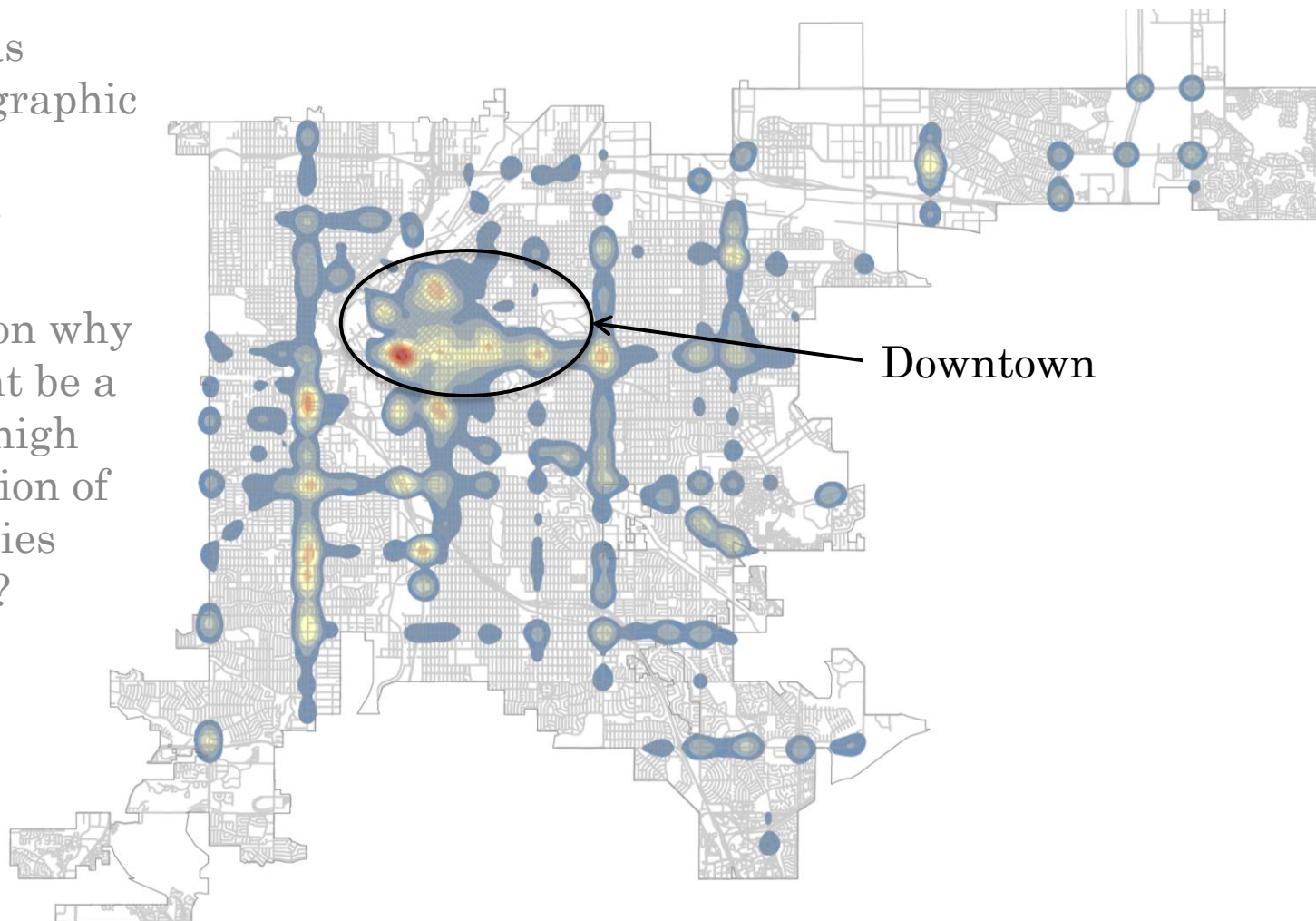


Note: Map not directly comparable to maps of other injury types.

MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

...as well as larger geographic areas, like downtown.

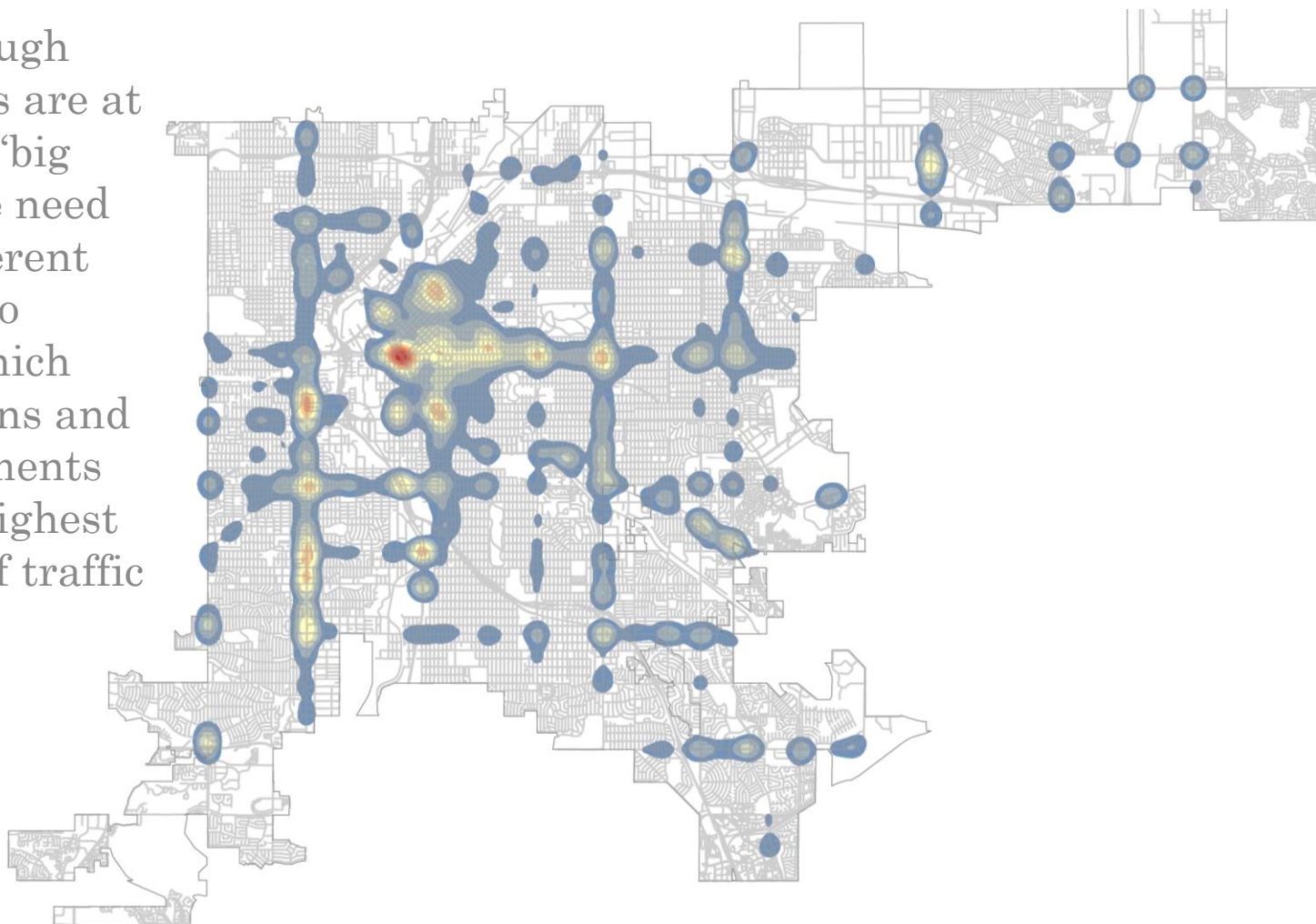
Thoughts on why there might be a relatively high concentration of MVC injuries downtown?



Note: Map not directly comparable to maps of other injury types.

MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

Useful though these maps are at seeing the ‘big picture’ we need to use different approach to identify which intersections and street segments have the highest numbers of traffic injuries.



Note: Map not directly comparable to maps of other injury types.

MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

Using buffers (i.e. circles) 300 feet in diameter we ranked the top twenty intersections and street segments by the number of MVC injuries treated by Denver Health’s paramedics that occurred in that buffer.



MOTOR VEHICLE CRASH INJURIES IN DENVER 9/1/11-8/31/16

Through this approach we generated a list of the intersections and street segments with the highest number of MVCs within a 150-foot radius during our study period.

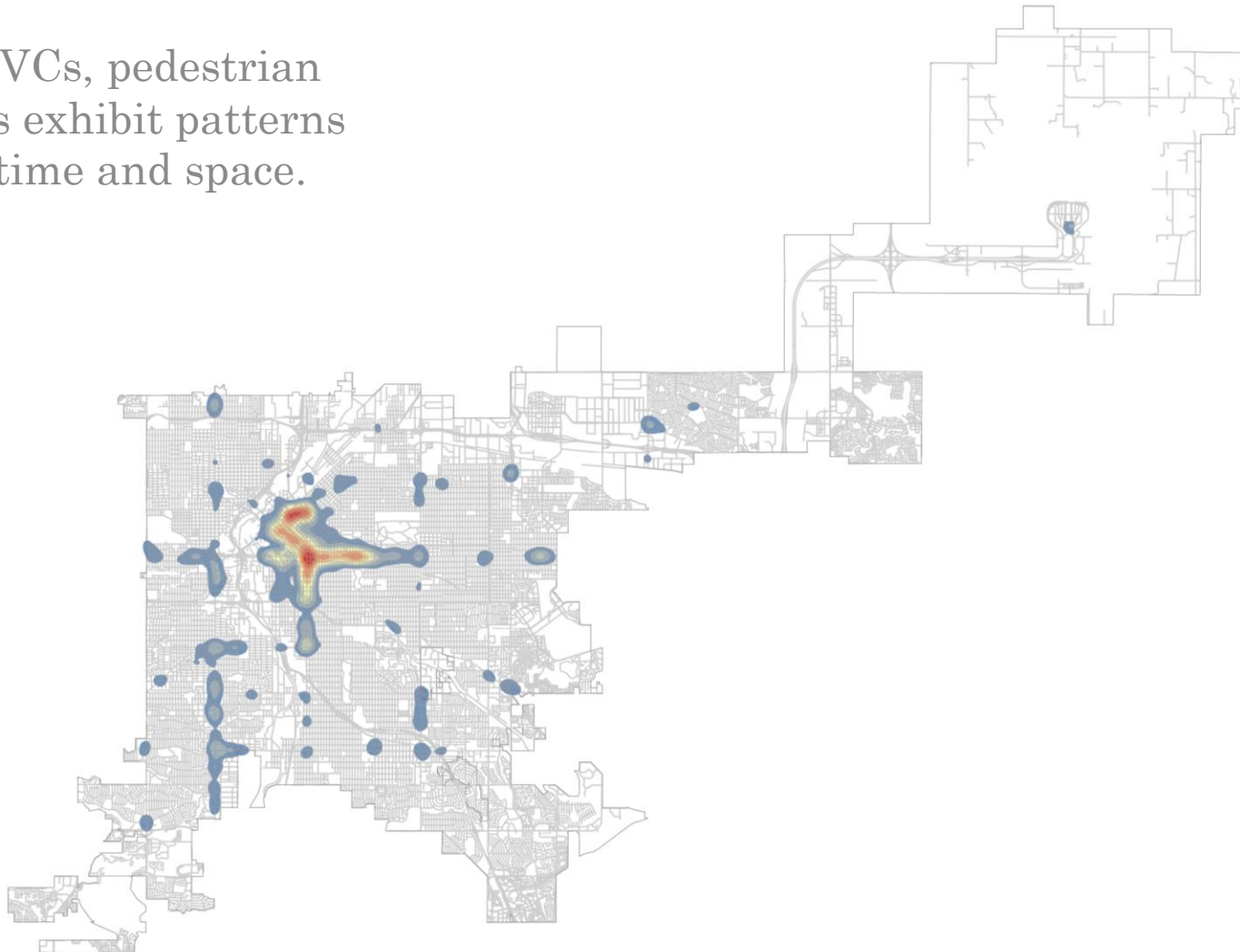
We repeated this approach for all other traffic injury types.

Rank	Location	Count
1	N Federal Boulevard & W 6th Avenue	130
1	N Federal Boulevard & W 8th Avenue	130
3	N Peoria Street & E Albrook Drive	102
4	S Federal Boulevard & W Evans Avenue	96
4	W Alameda Avenue & S Santa Fe Drive	96
6	S Quebec Street & Leetsdale Drive	95
7	1120 S Federal Boulevard	93
8	E. M.L.K. Jr. Boulevard & N Quebec Street	92
9	S Santa Fe Drive & W Mississippi Avenue	86
10	E Green Valley Ranch Boulevard & N Tower Road	82
11	N Tower Road & E 56th Avenue	78
11	S Federal Boulevard & W Florida Avenue	78
13	S Federal Boulevard & W Alameda Avenue	76
14	S Federal Boulevard & W Jewell Avenue	75
15	N Colorado Boulevard & E M.L.K. Jr. Boulevard	74

PEDESTRIAN INJURIES

PEDESTRIAN INJURIES IN DENVER 9/1/11-8/31/16

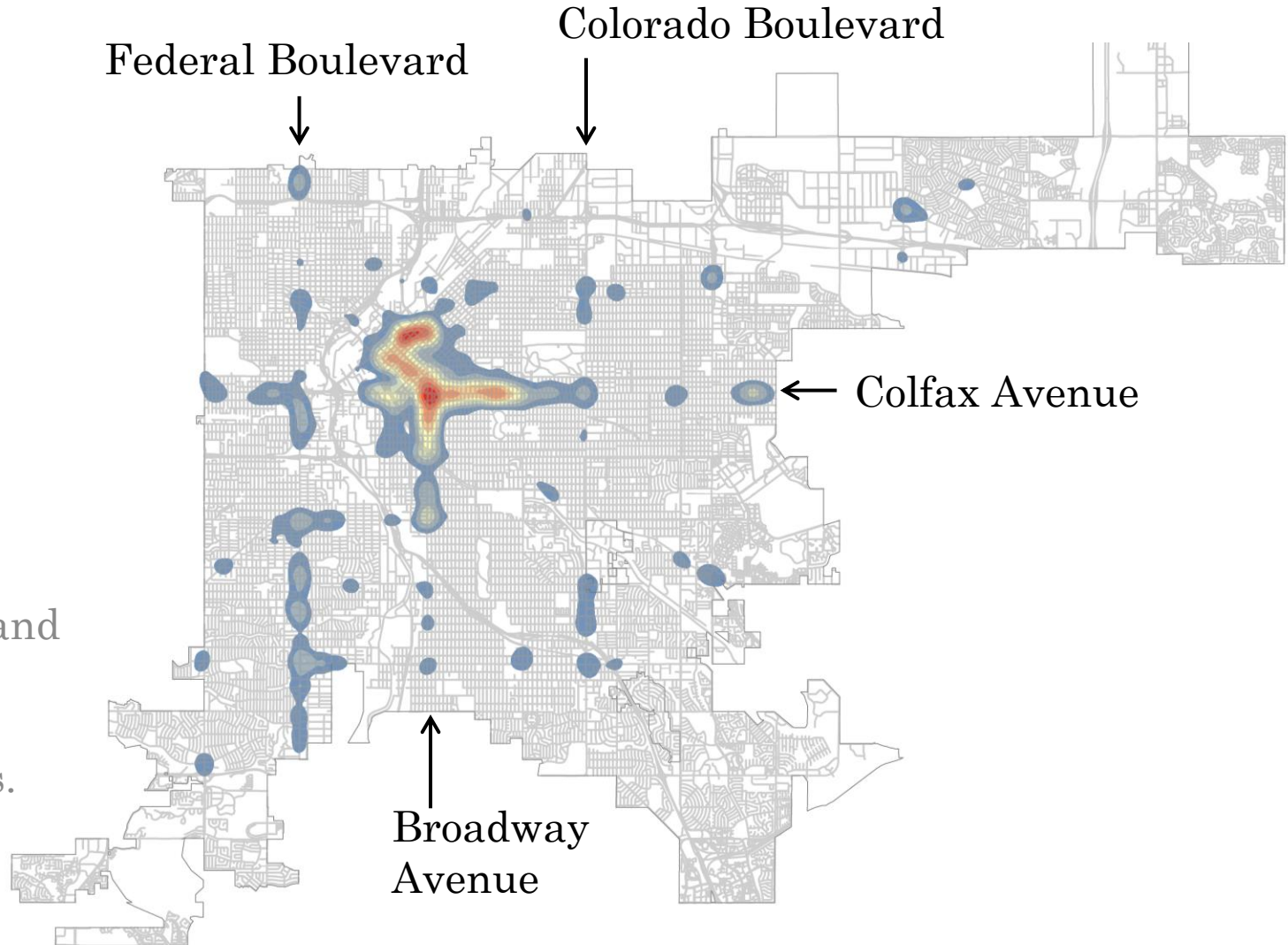
Like MVCs, pedestrian injuries exhibit patterns across time and space.



Note: Map not directly comparable to maps of other injury types.

PEDESTRIAN INJURIES IN DENVER 9/1/11-8/31/16

This map depicts the density of pedestrian injuries in Denver with the colorless areas having the lowest density, followed by blue, yellow and orange. Red shows high density areas.



Note: Map not directly comparable to maps of other injury types.

PEDESTRIAN INJURIES IN DENVER 9/1/11-8/31/16



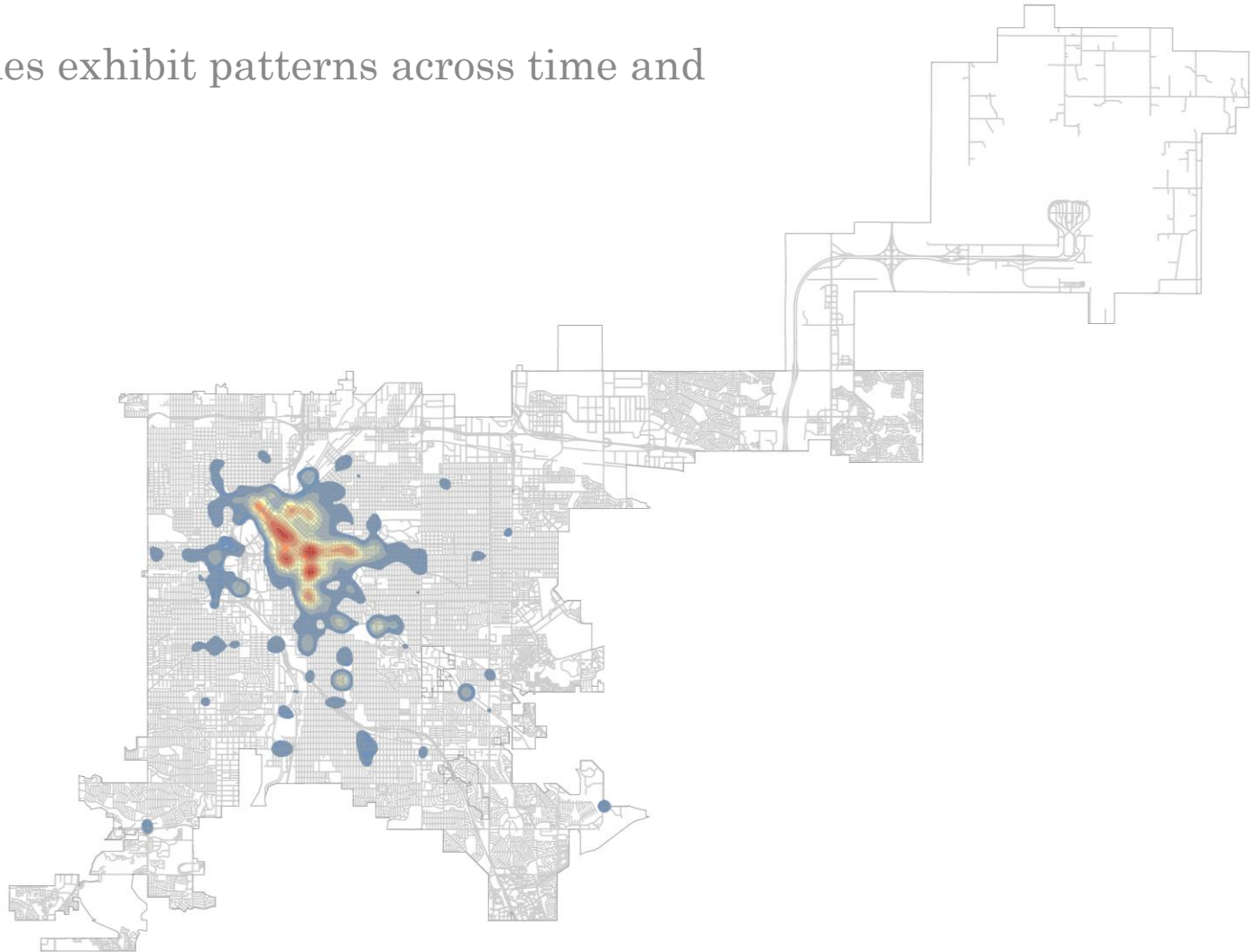
A list of the intersections and street segments with the highest number of pedestrian injuries within a 150-foot radius during our study period

Rank	Location	Count
1	E Colfax Avenue & N Broadway Street	24
2	2086 S Federal Boulevard	16
2	E Colfax Avenue & Park Avenue	16
4	E 13th Avenue & N Broadway Street	15
5	S Federal Boulevard & W Florida Avenue	14
6	20th Street & Market Street	13
7	E 10th Avenue & N Broadway Street	12
7	E Alameda Avenue & S Broadway Street	12
7	E Colfax Avenue & N Pennsylvania Street	12
7	Park Avenue W & N Broadway Street	12
7	W Alameda Avenue & S Federal Boulevard	12
12	E Colfax Avenue & N High Street	11
12	N Peoria Street & E Albrook Drive	11
12	S Sheridan Boulevard & W Dartmouth Avenue	11
15	S Federal Boulevard & W Mississippi Avenue	10
15	S Quebec Street & Leetsdale Drive	10
15	W 50th Avenue & N Federal Boulevard	10
15	W 50th Avenue & W Regis Boulevard	10
15	W Evans Avenue & S Clay Street	10

BICYCLIST INJURIES

BICYCLIST INJURIES IN DENVER 9/1/11-8/31/16

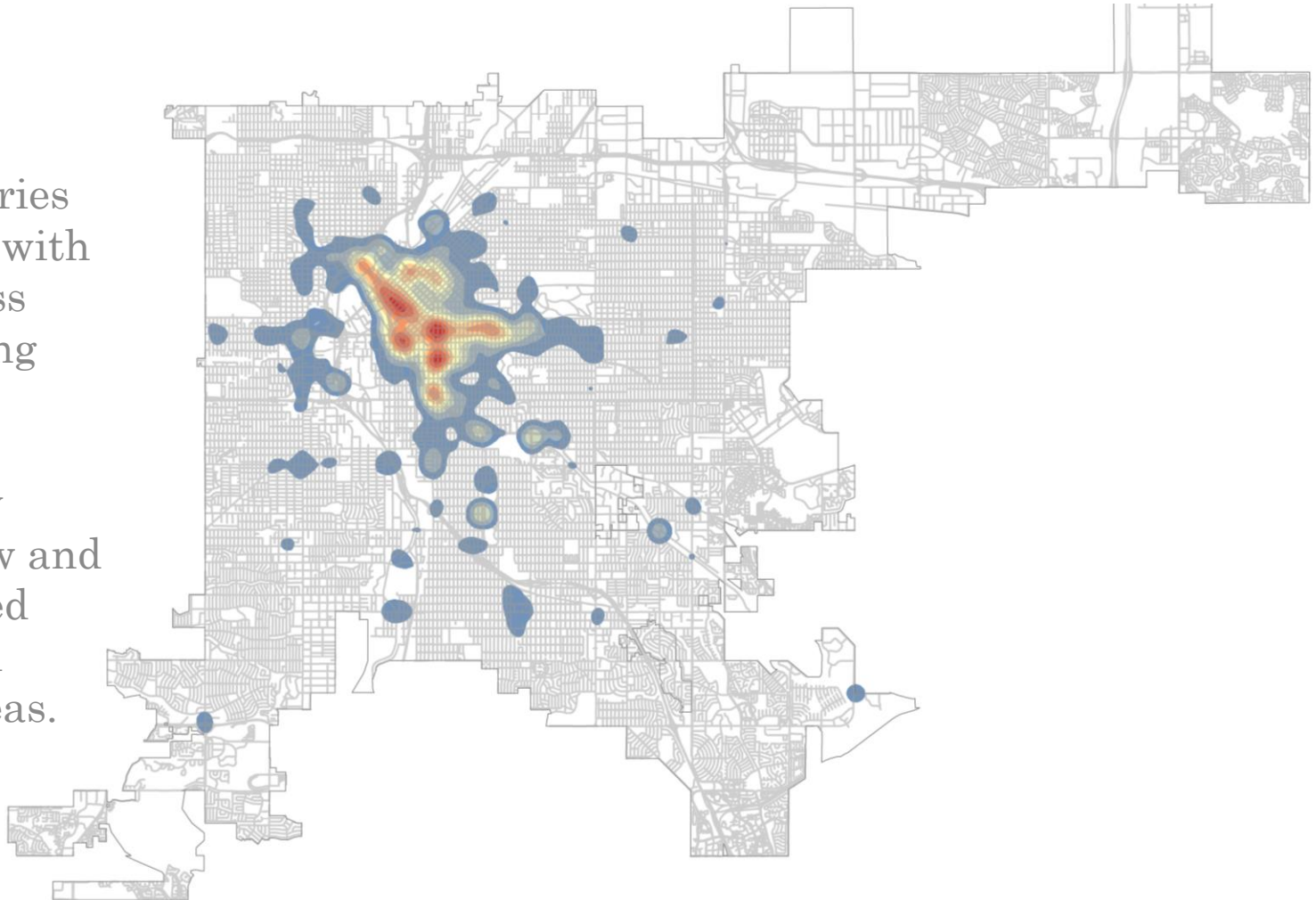
Bicycle injuries exhibit patterns across time and space, too.



Note: Map not directly comparable to maps of other injury types.

BICYCLIST INJURIES IN DENVER 9/1/11-8/31/16

This map depicts the density of cyclist injuries in Denver with the colorless areas having the lowest density, followed by blue, yellow and orange. Red shows high density areas.



Note: Map not directly comparable to maps of other injury types.

BICYCLIST INJURIES IN DENVER 9/1/11-8/31/16

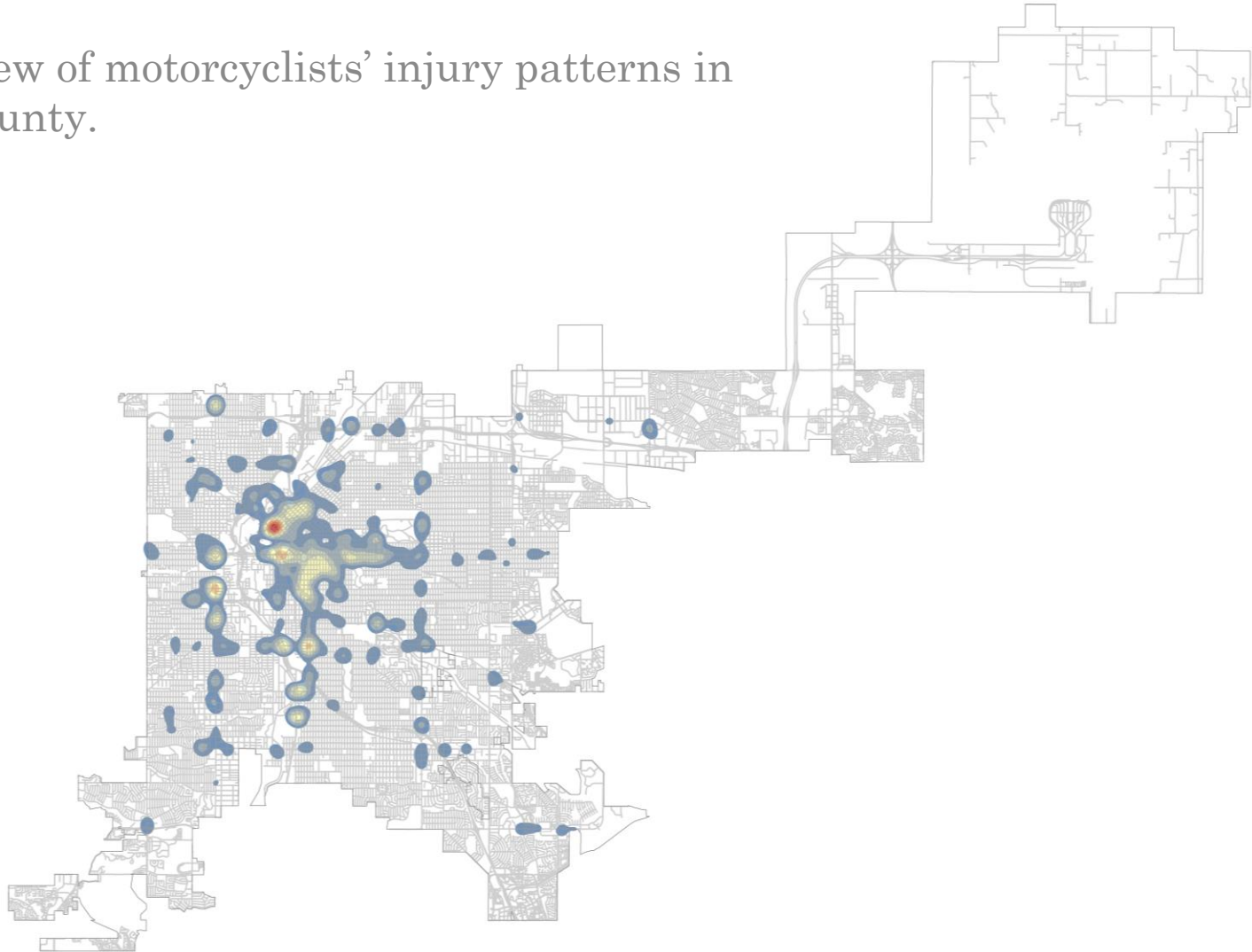
A list of the intersections and street segments with the highest number of bicyclist injuries within a 150-foot radius during our study period.

Rank	Location	Count
1	S Downing Street & E Kentucky Avenue	20
2	E 11th Avenue & N Lincoln Street	12
2	E 1st Avenue & N University Boulevard	12
4	20th Street & Wazee Street	11
4	E Colfax Avenue & N Broadway Street	11
6	E 17th Avenue & N York Street	10
6	W 12th Avenue & N Broadway Street	10
6	W 14th Avenue & N Speer Boulevard	10
9	15th Street & Little Raven Street	9
9	E 7th Avenue & N Broadway Street	9
9	E Alameda Avenue & S Broadway Street	9
9	N Broadway Street & N Speer Boulevard	9
9	W Colfax Avenue & N Speer Boulevard	9
14	1701 N Bryant Street	8
14	E Speer Boulevard & N Downing Street	8
14	N Speer Boulevard & Champa Street	8
14	W 8th Avenue & N Zuni Street	8

MOTORCYCLIST INJURIES

MOTORCYCLIST INJURIES IN DENVER 9/1/11-8/31/16

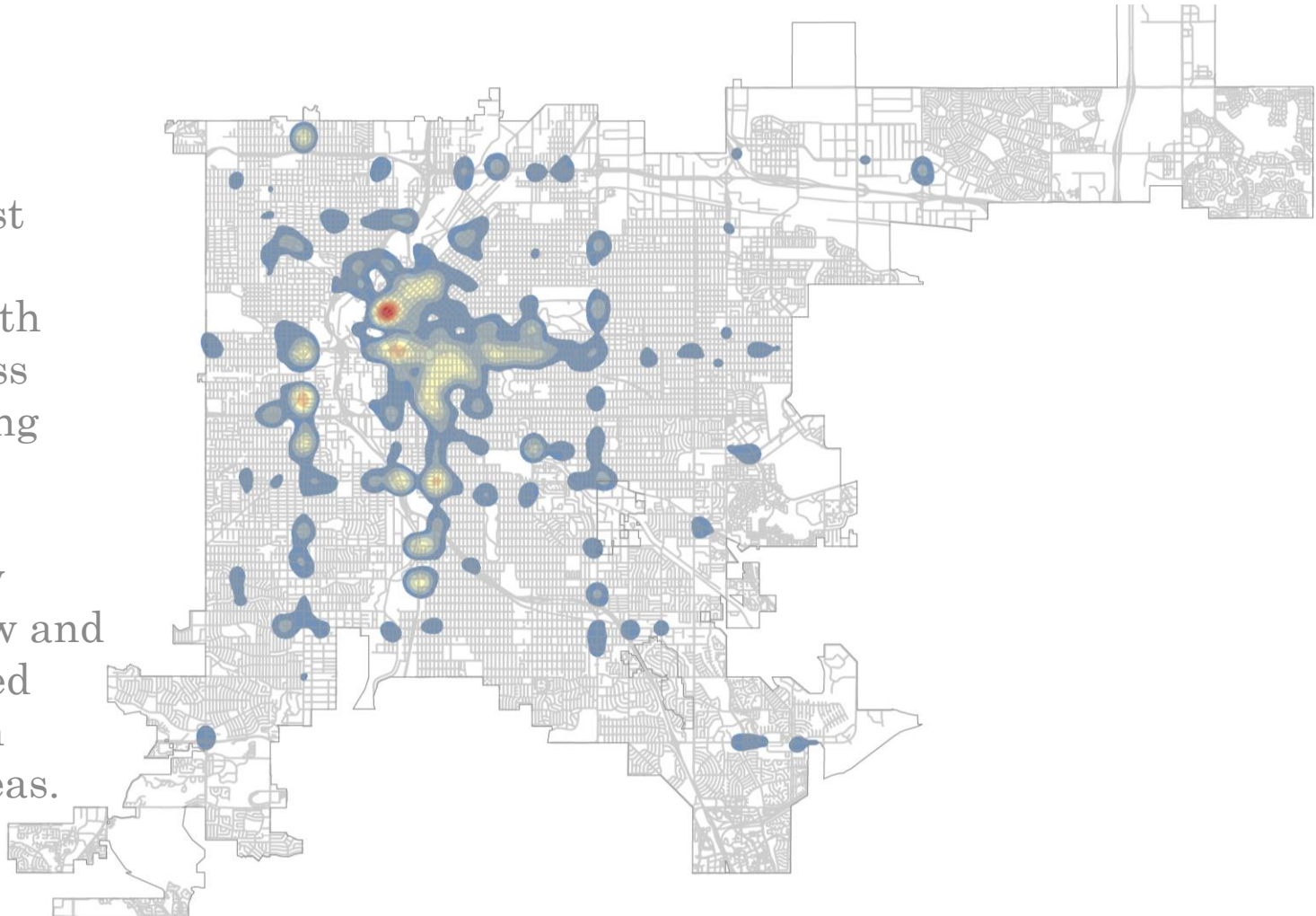
The full view of motorcyclists' injury patterns in Denver County.



Note: Map not directly comparable to maps of other injury types.

MOTORCYCLIST INJURIES IN DENVER 9/1/11-8/31/16

This map depicts the density of motorcyclist injuries in Denver with the colorless areas having the lowest density, followed by blue, yellow and orange. Red shows high density areas.



Note: Map not directly comparable to maps of other injury types.

MOTORCYCLIST INJURIES IN DENVER 9/1/11-8/31/16



A list of the intersections and street segments with the highest number of cyclist injuries within a 150-foot radius during our study period.

Rank	Location	Count
1	W 6th Avenue & N Federal Boulevard	10
1	W 8th Avenue & N Federal Boulevard	10
3	S Santa Fe Drive & W Alameda Avenue	8
4	N Federal Boulevard & W Colfax Avenue	6
4	N Speer Boulevard & W Colfax Avenue	6
4	W 50th Avenue & N Federal Boulevard	6
4	W Mississippi Avenue & S Santa Fe Drive	6
8	E 18th Avenue & N York Street	5
8	E 1st Avenue & N University Boulevard	5
8	S Santa Fe Drive & W Florida Avenue	5
8	Tremont Place & W Colfax Avenue	5
8	W 38th Avenue & N Fox Street	5
8	W Colfax Avenue & N Osage Street	5

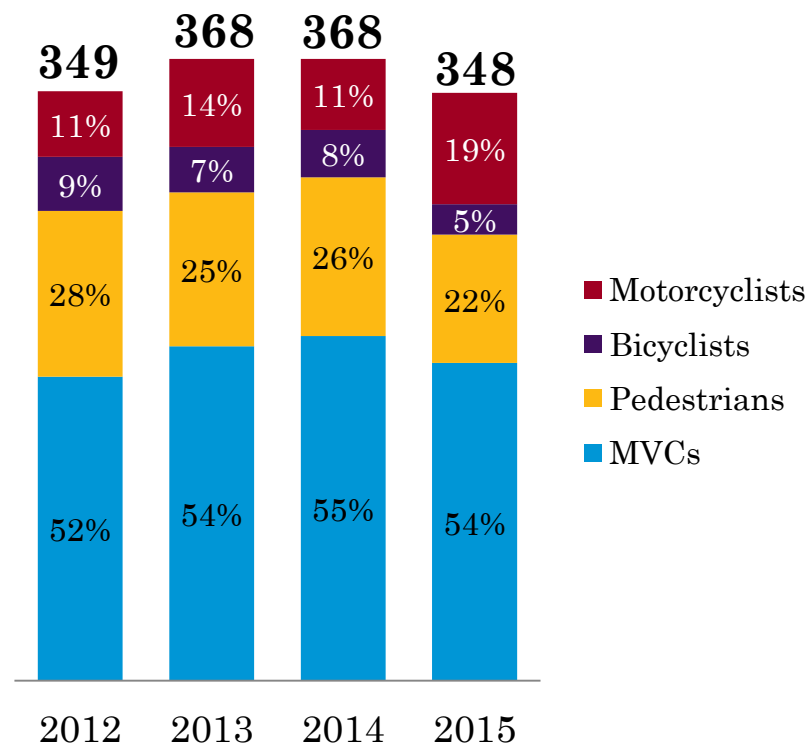
Note: Locations with fewer than 5 injuries are not displayed in order to maintain compliance with the Health Insurance Portability and Accountability Act (HIPAA).

SERIOUS TRAFFIC INJURIES

SERIOUS INJURIES IN DENVER

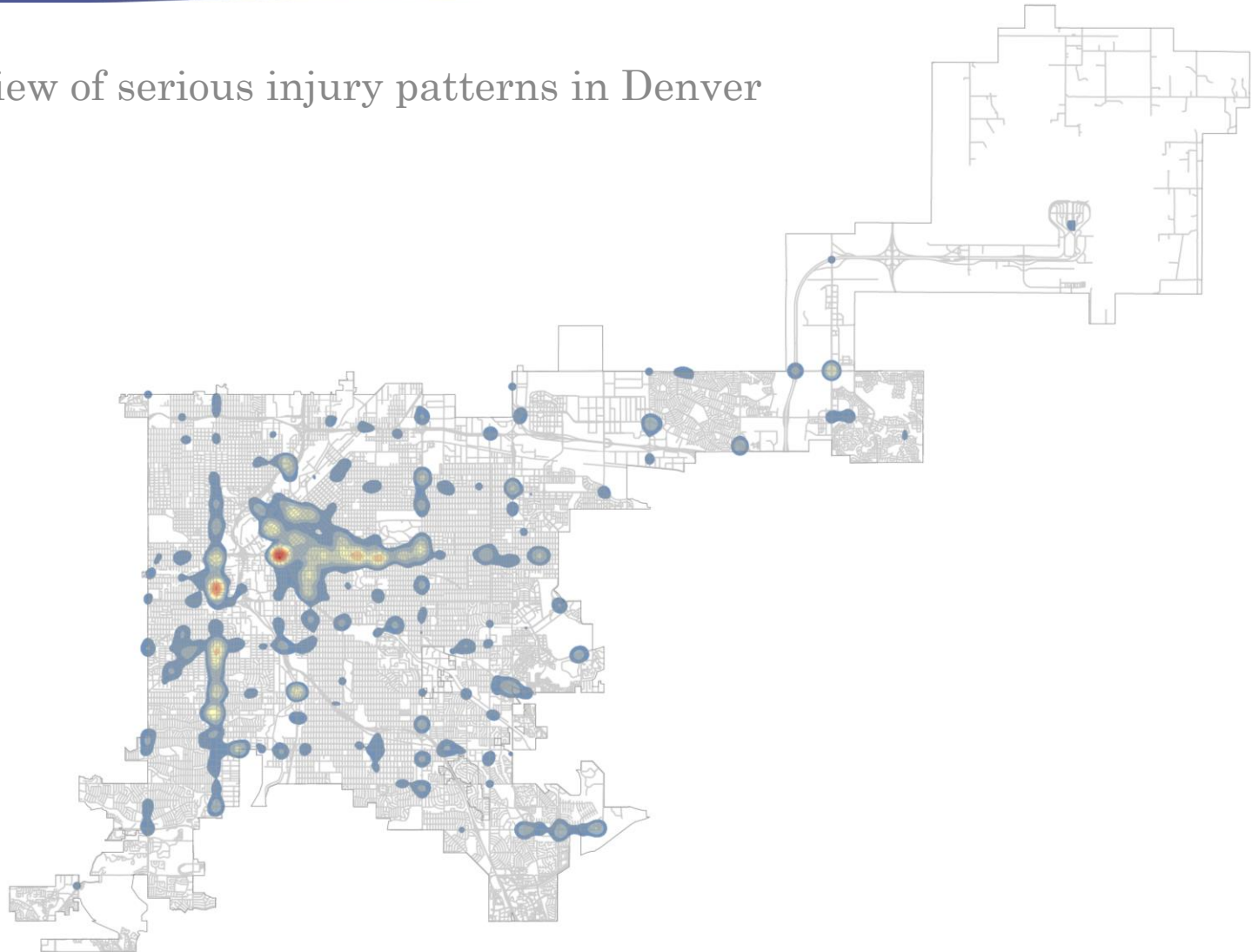
In this report serious injuries are defined as injuries that resulted in death (at the scene of the incident) or that required emergent transport, as determined by the paramedics.

Total Counts and Percentages of Serious Traffic Injuries by Year and Injury Type



SERIOUS INJURIES IN DENVER 9/1/11-8/31/16

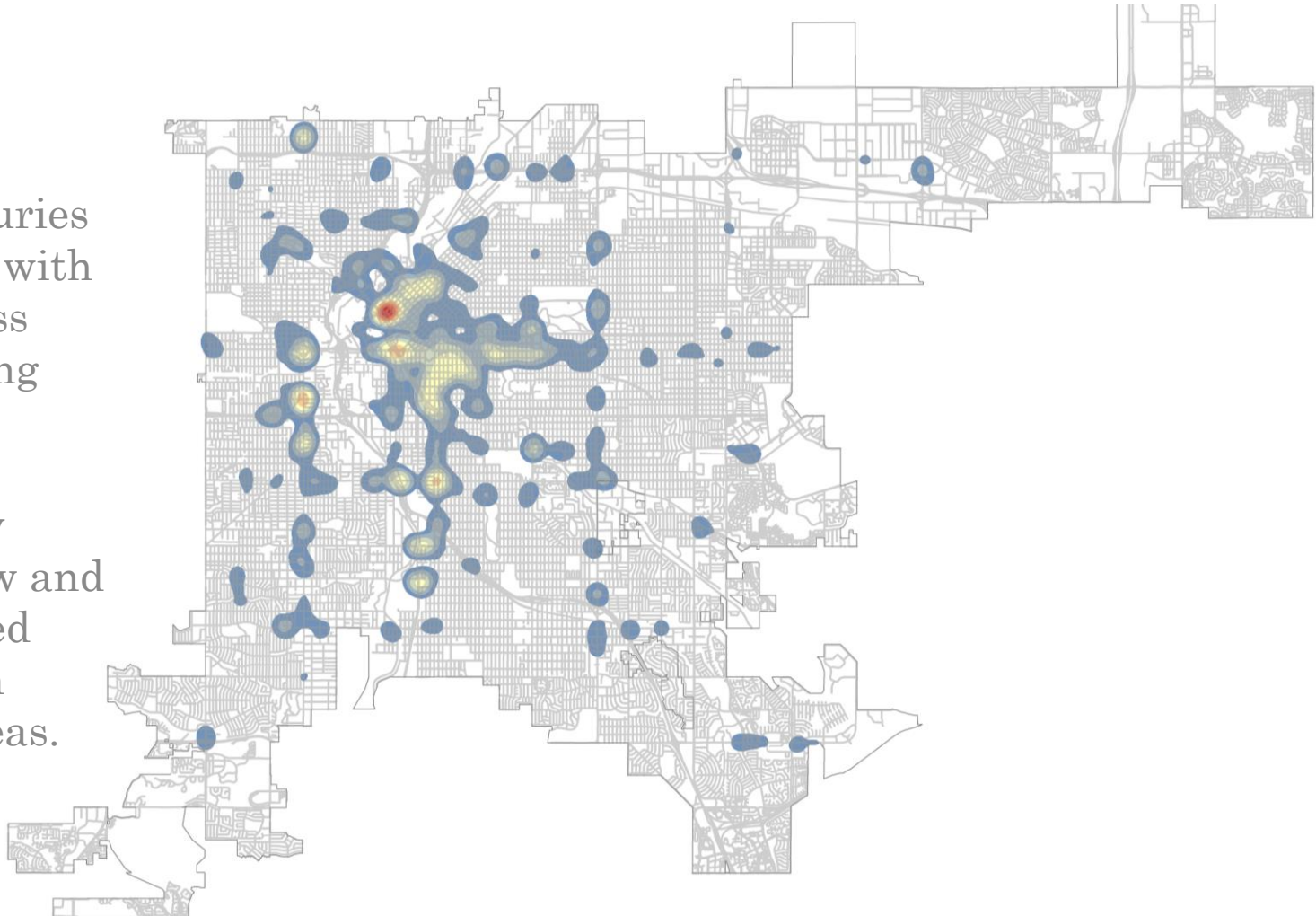
The full view of serious injury patterns in Denver County.



Note: Map not directly comparable to maps of other injury types.

SERIOUS INJURIES IN DENVER 9/1/11-8/31/16

This map depicts the density of serious injuries in Denver with the colorless areas having the lowest density, followed by blue, yellow and orange. Red shows high density areas.



Note: Map not directly comparable to maps of other injury types.

SERIOUS INJURIES IN DENVER 9/1/11-8/31/16

Intersections and street segments with the highest number of serious injuries within a 150-foot radius during our study period.

Rank	Location	Count
1	N Federal Boulevard & W 6th Avenue	15
1	N Federal Boulevard & W 8th Avenue	15
3	N Tower Road & E 56th Avenue	10
4	N Speer Boulevard & W Colfax Avenue	8
4	W Alameda Avenue & S Federal Boulevard	8
6	E 17th Avenue & N Colorado Boulevard	7
6	E Hampden Avenue & S Galena Street	7
6	S Federal Boulevard & W Florida Avenue	7
6	W Evans Avenue & S Zuni Street	7
10	E Colfax Avenue & N Colorado Boulevard	6
10	E Hampden Avenue & S Tamarac Drive	6
10	E M.L.K. Jr. Boulevard & N Quebec Street	6
10	Leetsdale Drive & S Quebec Street	6
10	N Chambers Road & E Andrews Drive	6
10	N Federal Boulevard & W 14th Avenue	6
10	N Federal Boulevard & W Colfax Avenue	6
10	N Speer Boulevard & Auraria Parkway	6
10	S Federal Boulevard & W Dartmouth Avenue	6
10	S Federal Boulevard & W Mississippi Avenue	6
10	S Federal Boulevard & W Virginia Avenue	6
10	S Santa Fe Drive & W Mississippi Avenue	6
10	W 38th Avenue & N Fox Street	6
10	W Colfax Avenue & N Kalamath Street	6

TECHNICAL NOTES

- **A Note on Incidence Rates:** Descriptive epidemiological reports and analyses often present data in the forms of prevalence and incidence estimates of proportions and rates, respectively. Transportation injury rates, specifically, are often calculated by dividing the number of crashes by “vehicle-miles traveled” or some other comparable denominator. The primary goal of using incidence rates in transportation injury epidemiology is to hold constant differences in exposure across time, space or some other factor. For example, we would expect to see more crashes in locations with higher traffic. If we were to estimate the incidence rates for particular intersections or street segments, we would have a way to compare intersections that have a lot of traffic with intersections that have very little traffic. This would add information to this report. However, by design, this report does not estimate incidence rates of traffic injuries for two primary reasons: 1) Detailed and comprehensive data on the number of drivers, pedestrians, bicyclists and motorcyclists are – to our knowledge – unavailable or insufficiently reliable to calculate estimates; and 2) The initial request for this report specified that maps and analyses of injury counts, rather than rates, were the primary goal of the report.
- **A Note on Representativeness:** The data analyzed herein were collected by Denver Health’s paramedics. Denver Health paramedics provide care for ~95% of the EMS encounters in Denver. Therefore, there is a chance that if the 5% of cases seen by other providers were geographically concentrated in particular areas (e.g. at county borders) there may be hotspots that were not be captured in this report.
- **A Note on Chance:** A wide array of statistical methods have been developed to assess the likelihood that the geographic distribution of a given collection of data is due to random variation (i.e. chance). Applying these methods to the Denver Health paramedics’ data is outside the scope of this descriptive report.
- **A Note on Location Data:** The geographic data that were analyzed in this report were assigned as a latitude and longitude by Denver’s 911 call center at the time of the call. Location data are collected to provide paramedics with information to find a patient in need of care. Because this is the primary purpose of the geographic data – rather than identifying areas in need of engineering or administrative intervention - the relationship between the location of the actual injurious incident and the point assigned by the emergency call operator is unclear.
- **A Note on Maps:** The maps in this report, representing average densities of particular injury types, were produced in ESRI ArcMAP using the Kernel Density Estimation (KDE) functionality. KDE is an approach to mapping the general spatial distribution of a given variable (in our case, the occurrence of injuries). Using this approach requires the selection of a *bandwidth* which determines the degree to which the map is “rough” or “smooth”. Large bandwidths result in more smoothing, where as small bandwidths retain more localized aberrations in the data. We chose a bandwidth of 1/8th Scott’s bandwidth* in order to provide enough granularity to observe variation in the data while still maintaining patients’ privacy and compliance with HIPAA.

* Scott, D.W. (1992) *Multivariate Density Estimation: Theory, Practice, and Visualization*. New York: John Wiley & Sons.

Please Send Questions or Comments To:

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