Pedestrian Injuries by Social Equity Factors in Oregon: Measuring Statewide Pedestrian Injury Disparity Using Common Data

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ABSTRACT

Past research and planning has highlighted the existence of pedestrian injury disparities throughout the United States. Some local agencies have performed cursory analysis in Oregon, but no statewide analysis of pedestrian injuries has been completed to see how these injury outcomes differ by race and income. This paper first documents racial pedestrian fatality disparities in Oregon, and then presents an analysis using a simplified index to explore if areas with higher concentrations Black, Indigenous and People of Color (BIPOC) and or lower-income Oregonians face disproportionate levels of pedestrian crashes and fatalities. The analysis shows that BIPOC Oregonians experience higher levels of pedestrian fatalities, and that these disparities have worsened in recent years. Further, census tracts with higher proportions of BIPOC and low-income Oregonians experience higher rates of pedestrian injuries and fatalities, as well as being subject to more vehicle miles travelled, more high-speed arterials, and higher levels of travel by walking and transit. The analysis approach provides a set of tools to analyze pedestrian injuries and disparities which can be easily implemented using accessible data sources, and provides a starting point for agencies to assess and begin acting to improve pedestrian safety inequities.

Keywords: Pedestrian, safety, equity, tools, index.

INTRODUCTION

Past research and planning has highlighted the existence of pedestrian injury disparities throughout the US and some local agencies have performed cursory analysis in Oregon. African-Americans and Native Americans are disproportionately likely to be pedestrian fatality victims, with the US population being 13% Black in 2010, but 17% of pedestrian fatalities between 2002 and 2016 were Black; while these numbers for Native Americans were 0.9% of the population and 2.3% of pedestrian fatalities (*1*). Although income is not recorded in most crash data, numerous studies have found that areas with lower incomes and higher poverty rates are associated with increased injury and fatality risk (*2*). A national study found that for every $1,000 decrease in a Census tract's median income pedestrian fatal injuries would be expected to increase by 1 percent (*3*). Another study found that Census tracts in metropolitan areas with per capita income of less than $21,559 had pedestrian fatality rates twice as high as in areas with per capita incomes of greater than $31,356 (*4*). That study included data on some large Metro areas, including the Portland, Oregon region; for 2008 to 2012, the overall Portland metro area had a pedestrian fatality rate of 5.3 fatalities per 100,000 residents, while for tracts with over 25% of residents living in poverty that number was 12.8 fatalities per 100,000 people, and for tracts less than 15% in poverty that number was 3.5 fatalities per 100,000 (*4*). A report from Oregon Walks examining pedestrian fatalities in Portland from 2017 to 2019 found that Black Portlanders with overrepresented among fatalities, accounting for 17% of pedestrian fatalities but only 5.8% of the Portland population (*5*).

However, no statewide analysis of pedestrian injuries and fatalities in Oregon has been completed to see how these injury outcomes differ by race and income. Disparities in pedestrian safety outcomes are most likely attributable, at least in part, to levels and types of exposure; however, there are few tools to assess and compare levels of walking and the types of traffic and transportation environments based on equity factors such as income and race. This paper uses data that are mostly available throughout the US and relatively simple methods to measure and highlight pedestrian injury disparities by race and income. The analysis occurs in two stages with the first analysis using data from the Fatality Analysis Reporting System (FARS) and U.S. Census to calculate age-adjusted pedestrian fatal injury rates by race in order to measure disparity directly based on these data. The second analysis uses a z-scoring method to categorize Census tracts into groups based on the poverty and race concentration and then to calculate pedestrian injury rates for those broad categories. Together these two analyses describe the existence of pedestrian injury disparities by race and income and based on information from the z-scoring method, helped shed some light on the potential drivers of these disparities.

In addition to highlighting disparities in pedestrian injury by race and income, this work offers a set of tools that other states and regions could use to measure pedestrian injury disparities. These tools are available through Github and can be used with mostly universally available data. The results should serve as a starting point for public agencies to understand how people in their jurisdictions experience pedestrian injury in order to take further steps to develop intervention strategies.

BACKGROUND

The transportation system plays an important role in connecting people to economic and social opportunities but this access is not equitably distributed. This inequity can be observed in people's travel behavior and the built environment in which that travel occurs. While travel behavior is complicated, evidence demonstrates that household income is a strong predictor of vehicle ownership (*6*) and neighborhood amenities like a walkable environment (*7*), both of which influence travel behavior. Further, land use and zoning policies, home lending practices, and housing affordability have all contributed to income and racial differences in housing locations. Indeed, over the past 40 years, income-based housing segregation has increased dramatically (*8*). Housing policies and practices effectively cut off buying a home as a viable pathway to personal wealth creation for many Black families, resulting in a current 10 to 1 wealth gap between White and Black households (*9*). Such spatial separation has negative impacts on low-income and BIPOC communities, ranging from increased exposure to environmental hazards, inferior schools, exposure to crime, and diminished access to jobs (*10*). The resulting segregated housing landscape contributes to different transportation experiences, travel options, and safety conditions.

National data shows that lower-income and BIPOC households have fewer transportation options and are more reliant on walking and transit, modes that put them at greater risk of pedestrian crashes. For example, data from the 2017 National Household Transportation Survey show that lower-income households and households with a Black primary household respondent were particularly likely to not have a car (*11*). In terms of income, 26% of households earning under $25,000 do not own a car, compared to 5.2% of those earning $25,000 to $49,999, 3.1% of those earning $50,000 to $99,999, and 2.3% of those earning $100,000 or more. In terms for race, only 6% of white households had zero vehicles, while 23.3% of Black households, 15% of American Indian or Alaska Native households, 11.2% of Asian households, and 11.4% of Latino/Hispanic households had zero vehicles. Census data shows that low-income and BIPOC workers are much more likely to walk or take transit for their commute trips, with 10% of those earning under $25,000 commuting by walking or transit compared to 5.8% of those earning $25-$75,000 and 8.3% of those earning over $75,000; while 6% of white workers commute by walking or transit, compared to 9% of Latino/Hispanic workers, 13% of Black or African workers, and 15% of Asian workers (*12*). The NHTS data also reveals that lower-income households feel pressure to walk and take transit more due to financial burden; 29% of those in the under $25,000 income bracket agreed that they choose to walk in order to reduce the financial burden of travel, compared to 17% of those households earning $25,000 to $49,000, 14% of those earning $50,000 to $99,999, and 11% of those earning $100,000 or more; and 21% of those earning $25,000 or less agreed that they take public transit to reduce the financial burden of travel, compared to 9 to 11% of those in other income categories (*11*).

Currently, there is limited direct research showing that lower-income and BIPOC individuals are disproportionally exposed to higher volume and higher speed arterials – a gap which this research seeks to partially address. However, there is evidence that lower-income areas have fewer pedestrian facilities to help people navigate traffic threats. For example, a national study found that 89% of streets in high-income areas have sidewalks on one or both sides of the street, compared to only 59% of streets in middle-income areas, and 49% of streets in low-income areas (*13*). The study also found that streets in high-income areas are much more likely to have marked crosswalks (13% of streets), compared to 8% of streets in middle-income and 7% of streets in low-income areas; while 75% of streets in high-income areas have street or sidewalk lighting, compared to only 51-54% of those in middle- and low-income areas (*13*).

While there are some tools to help guide states in pedestrian risk assessments, such as FHWA's 2018 *Guide for Scalable Risk Assessment Methods for Pedestrians and Bicyclists* (*14*), we did not identify simplified tools for assessing exposure and environment disparities by race/ethnicity and income. Such a tool would assist agencies in understanding, conveying and responding to ways in which pedestrian risk is unequally distributed.

DATA AND METHODS

Data

A summary the data sets utilized to conduct the analysis is provided in Table 1. These datasets include:

Traffic injury data derived from police records and driver self-reports of incidents that happen on city streets, county roads, and state highways maintained by the Oregon Department of Transportation's (ODOT) Crash Data Unit. The Crash Data Unit produces the Crash Data System (CDS) which is the authoritative source of crash incidents in Oregon For the purposes of this analysis, only pedestrian injuries on non-access controlled (functional classifications: arterials, collectors, and local) roads are used since pedestrian injuries on interstates and expressways likely have little to do with surrounding sociodemographic and built environmental characteristics. Fatal, severe and total pedestrian injury counts by tracts come from ODOT's CDS crash data file. These data are assigned to the census tract in which they are located with no manual adjustments.

The National Highway Transportation Safety Agency (NHTSA) maintains the Fatality Analysis Reporting System (FARS). FARS collects traffic fatality data through state data files, with the police traffic crash report as the primary source. Additionally, FARS analysts use other state data, such as driver records, vehicle records and medical records. Trained personnel interpret and code data directly from the police traffic crash reports onto an electronic file. Race of the fatality injured crash participant is derived from the death certificate. Data for this project were accessed from the NHTSA FTP site and downloaded and formatted using the R statistical computing platform. These data will be used to calculate age-adjusted population based pedestrian injury rates by race in order to understand pedestrian injury disparities in Oregon.

A number of useful datasets for this research project were gathered from the U.S. Census which tracks population counts and characteristics such as demographics data each year using a long form survey. For demographic measures such as percent Black and percent Asian the total number of people in these Census categories are divided by the total population in the tract to calculate the proportion. Data on the percent of workers that commute by walk and transit comes from the U.S. Census and is available at the block group level but for this research these measures were aggregated to the tract but otherwise used as is with no calculations. Similarly, the number of vehicles per household was taken as is from Census for use in this analysis.

ODOT's Transportation System Monitoring Unit maintains the Table of Potential Samples (TOPS) dataset and are reported to the Federal Highways Administration on an annual basis through the Highway Performance Monitoring System (HPMS). Information on the vehicle miles traveled (VMT) and roadway speeds data are derived from TOPS. These data are available at a disaggregate level for all streets with a functional classification of minor collector and above for years 2011 through 2019. Since the scale of these data is at the network level, these data were aggregated to Census tracts for use in analysis. Transit stop information is derived from statewide database of General Transit Feed Specification (GTFS) data. The location of stops are available for the entire state because ODOT's Public Transit Division has spent resources and staff time making sure all relevant transit providers in Oregon collect their service information and submit it using this data standard. The density of alcohol establishments is measured using the count of alcohol licenses divided by the land area of the census tract where these establishments are located. Alcohol establishments include places of both on-site and off-site consumption such as bars or pubs as well as grocery and convenience stores.

Table 1: Dataset Purpose and Source Summary Table

		Data Purpose	
Dataset	**Agency \Source**	**Pedestrian Fatalities by Race**	**Race Ethnicity and Income Index**
Crash Data System (CDS)	Oregon DOT		✓
Fatal Accident Reporting System (FARS)	NHTSA	✓	
US Census	US Census Bureau	✓	✓
Built Environment & Traffic Exposure	ODOT; GTFS; OLCC		✓

Analysis Approach

This section details the analysis approach used to assess pedestrian fatality rates for different race and ethnicity groups in Oregon, and to develop a simplified race/ethnicity and income index to document the extent to which areas with higher proportions of BIPOC and low-income Oregonians are subject to more pedestrian crashes and fatalities, as well as differences in exposure and environment.

Pedestrian Fatalities by Race/Ethnicity

FARS data directly measure the race of the pedestrian involved in a fatal crash and when paired with population data from Census are valuable to understand disparate injury outcomes. Fatal injury burden is measured using age-adjusted rates (*15*) and is calculated using the counts of fatal injuries combined with population counts of people by age cohort for each race adjusted by using the US population as the standard population. Age-adjusted rates account for the variability of age-specific mortality rates and make comparisons across geographies possible. These rates are calculated using the following equation:

$$\frac{D}{N} = \frac{\sum d_i}{N} = \frac{\sum n_i\,(d_i/n_i)}{N} = \sum(n_i\,/N)(d_i/n_i) = \sum w_i(d_i/n_i)$$

Where:

D = deaths (fatally injured pedestrians)
N = population (Oregon)
i = age-stratum
d_i = age-stratum specific deaths
n_i = age-stratum specific population
w_i = weights from standard population

These calculations are equivalent but when comparing Oregon-specific rates to other states for instance, the age-adjusted result should be used to account for age differences in the populations being compared. The results reported in this chapter present rates using person years, which uses the total population over multiple years as opposed to the population for any one year. This principle of epidemiology aims to more accurately capture the time people are exposed to a given disease or health outcome, in this case pedestrian injuries.

Since most of Oregon's population is white, the number of pedestrians in BIPOC categories can be small for some time periods so rates are an important normalizer to help understand disparate outcomes. This research utilizes guidance that Oregon Health Authority's Health Promotion and Chronic Disease Prevention unit developed titled *Guidelines for Reporting Reliable Numbers* (*16*). This guidance recommends that for individual strata at least 12 observations are available to report without a notice of caution for statistical reliability. Additionally, this guide recommends that if the calculated standard error exceeds 30% that readers are notified of the potential unreliability of the reported quantity (*16*). This analysis follows that guidance by including the three instances where the standard error threshold is not met. These instances include the rates calculated for both periods of data for Native Hawaiian and Pacific Islander where counts of pedestrian injuries are very low. The third instance of unreliable estimates occurs for Black pedestrian rates in the 2009-2013 period where counts of pedestrian deaths are too small to accurately determine statistically significant differences compared to the state average. Margins of error are also shown which can help readers see where the precision of the calculated rate makes meaningful comparisons problematic.

Age-adjusted population-based rates are a measure of the burden on the population of a given health outcome, in this case the burden of fatal pedestrian traffic injury. Using FARS pedestrian injuries and population data from the Census for each age cohort, these rates can be calculated to understand whether disparities exist based on race. In addition to the age-adjusted rates, margins of error are presented which describe the confidence intervals of the fatal injury rates. Confidence intervals are measures of uncertainty associated with the age-adjusted injury rates (*17*). A large standard error and confidence interval reflect a less certain estimate. The size of these measures depends on the number of deaths (numerator) and the base populations (denominator) for each group. Large numbers of deaths and large base population lead to greater certainty in estimating age-adjusted death rates. These measures do not incorporate uncertainty associated with age misreporting or inconsistencies in racial and ethnic identification and do not attempt to handle issues of underreporting.

Race, Ethnicity and Income Index Analysis

A composite standardized scoring index was used to assess whether Census tracts with higher proportions of low-income and / or BIPOC residents are subject to higher levels of pedestrian injury and fatality. Standardized scores, or z-scores measure the difference between the value of a given Census tract and the statewide average. Based on these index values, built environment and traffic characteristics, such as higher speed and volume arterials, are also summarized.

Many versions of composite indices exist that collapse multiple factors into a single index value with an aim to simplify measures of social disadvantage or social vulnerability. The Centers for Disease Control (CDC) have constructed a Social Vulnerability Index (SVI) that employs 14 variables from the Census including proportion of people 17 years of age and below, people 65 years of age and above, single parent households with children 17 years of age and below, racial/ethnic minorities, people living in group quarters, people below poverty level, unemployed, no high school diploma among people 25 years of age and above, people who have limited English proficiency, housing infrastructure with 10 or more units, households that have more people than rooms, mobile homes, no vehicle access, and per capita income (*18*).

This analysis sought to utilize a very simple index that would be easy to create and, more importantly, would result in an output that would be easy to interpret and convey. The variables used in the Race/Ethnicity and Income Index (REII) for this work and include the following measure:

- Poverty Rate - Percent of the population living at or below the poverty line
- BIPOC % - Percentage of the population that are American Indian or Alaskan Native, Asian, Black, non-White Hispanic, and Native Hawaiian or Pacific Islander

These population factors are used to calculate z-scores to determine if the given measure is higher or lower relative to the mean of that value, in this case the statewide average for Oregon. Z-scores are helpful tools for locating individual observations that differ significantly from the mean. Z-scores are based off of population metrics, meaning they represent where a particular value falls relative to the entire population, not the sample of interest. A positive z-score means that a particular corresponding raw score fell above the population mean or average. A negative z-score represents a raw score that falls below the population mean. The numerical value of the z-score is actually the number of standard deviations above or below the mean, depending on the sign of the score. A z-score in the middle of the normal distribution has a mean of 0 and a standard deviation of 0, meaning that the score falls in the exact center of the normal distribution (*19*). Because z-scores standardize the values for individual metrics (e.g. Poverty, % BIPOC, etc.) multiple metrics can be combined into an index. z-scores are calculated for each metric using the following equation.

$$Z_{id} = \frac{x_d - \mu_d}{\sigma_d}$$

Where:

Z is the standardized score for tract *I* for REII measure *d*
x is the REII measure for tract *I* for element *d*
μ is the average statewide value of REII measure *d*
σ is the standard deviation of the REII measure *d*

The index represents the composite score of the combined metrics by adding each z-score together. The resulting index measure shows how the select measures compare relative to the mean of the population (the state average). Based on the number of standard deviations from the mean, these composite index values are then grouped into lowest, low, moderate, and high concentration based on their distance from the mean. For this research the thresholds for the low and moderate category were set slightly below the standard deviations to ensure these categories has adequate population and pedestrian injuries. Figure 1 shows where those cut points fall and how many census tracts are included in each of the REII categories.

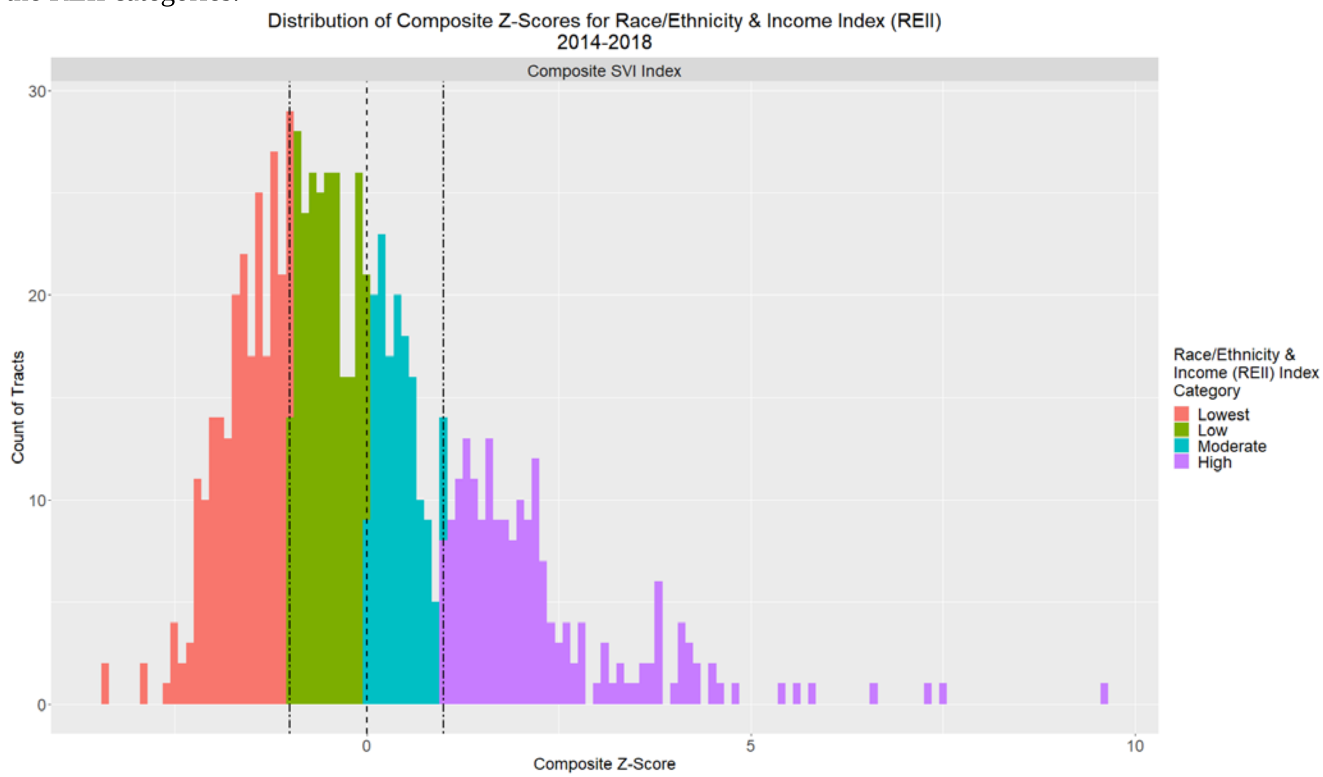

Figure 1: Distribution of Composite Z-Scores for Social Vulnerability Index 2014-2018 Data

FINDINGS

Pedestrian Fatality Rates

The results presented in Figure 2 show five-year fatal injury rates in Oregon and highlight the disparate pedestrian fatal injury outcomes of BIPOC populations, with Black people facing the highest disparities in this period of data with 4.7 pedestrian fatalities per 100,000 people. Native Hawaiian and Pacific Islander (NHPI) people have a high rate but the low number of fatalities and base population results in a statistically unreliable rate. The next highest rate is for American Indian and Alaskan Native (AIAN) followed by Latinx and then Asian people with 3, 2.7, and 2.4 pedestrian fatal injuries per 100,000 people respectively. An aggregate rate was also calculated that aggregates all BIPOC fatalities and base population and shows that overall the pedestrian injury rate for BIPOC is 2.8 pedestrian fatal injuries per 100,000. The rates for all BIPOC populations (except for NHPI) are significantly (considering the confidence intervals) higher than the state average and higher than the rate for White people.

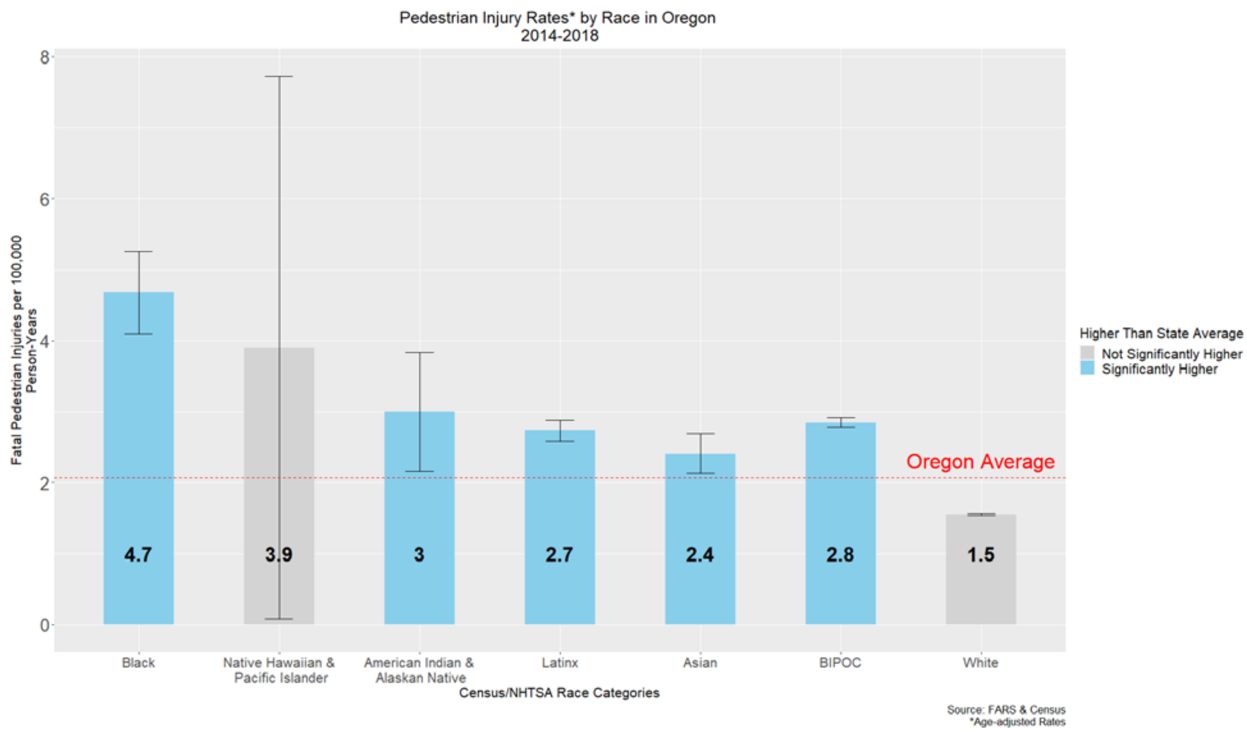

Figure 2: Age-Adjusted Fatal Injury Rates per 100,000 People 2014-2018

Though the rates show a significant disparity in the most recent data these rates vary over time. Figure 3 below shows two five-year periods including the years from 2009 to 2013 and 2014 to 2018. The measured rate is shown as text in the chart for clarity. American Indian and Alaskan Native populations exhibit a higher burden of pedestrian death in both periods with the disparity shrinking between periods. The pedestrian fatal injury rate for Asian populations was slightly lower (though not significantly) than the state average in the first period but increased in the second period to be higher than the state average. The rate for Black populations was at or near the state average for the first period but then increased too over two times the state average. The rate for Latinx populations was 33% higher than the state in the first period and increased to 75% higher than the state average the latter period. For Native Hawaiian and Pacific Islander populations there were no recorded pedestrian traffic deaths in the first period and so no reported rate and therefore this population has been masked from the figure. The rate for BIPOC population as a composite group was 10% higher than the state average in the earliest period of data but then increases in the second period to be 15% higher in the latter period. The rate for white populations slightly lower than the state average in the first period with the difference growing into the second period.

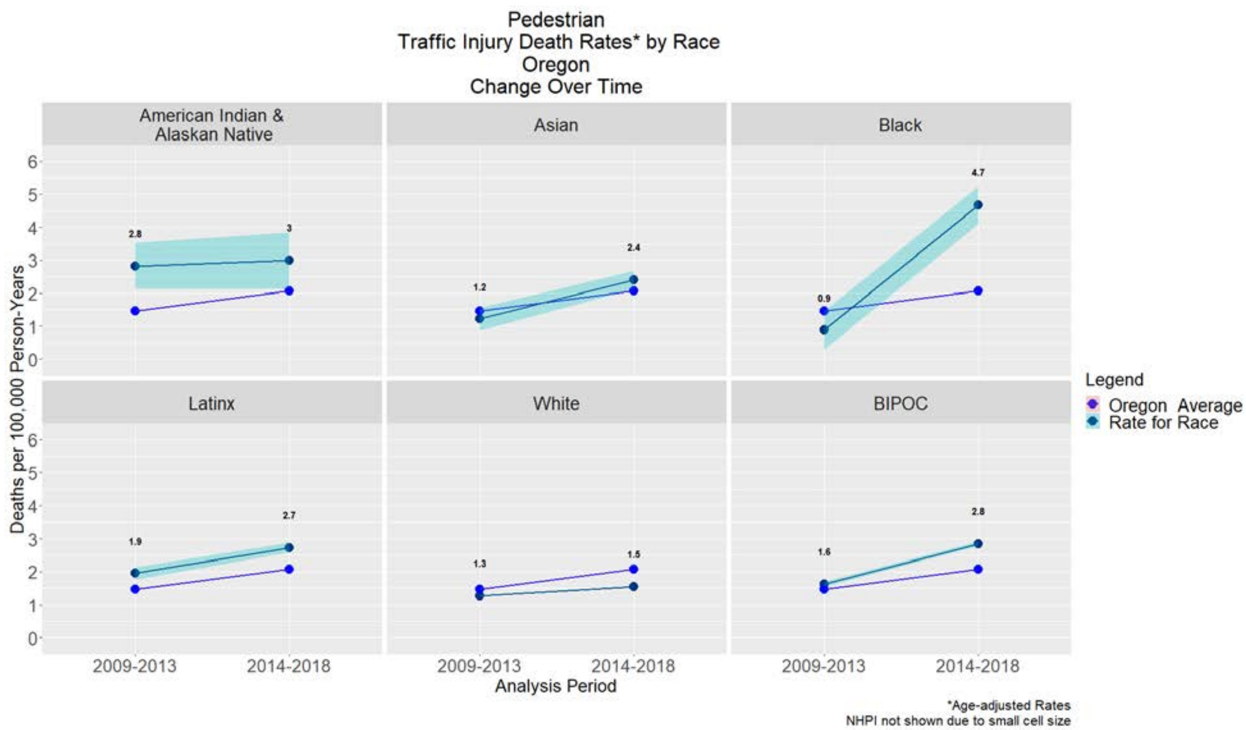

Figure 3: Age-Adjusted Fatal Injury Rates per 100,000 People over Time

Index Analysis Findings

Using the REII to categorize Census tracts reveals where there are concentrations of people above and below the state average for the selected socio-demographic variables. Using these categories, relevant injury, travel, and built environment measures are summarized in Table 2 and shows how the REII elements relate to the overall categories. For instance, in the lowest REII category the average percentage of the population living in poverty, for all the tracts included in this REII category, is 8% while the average for the tracts designated as low, moderate, and high is 12%, 15% and 23% respectively. Compared to the statewide average poverty rate of 14% it is simple to see how the Z-score method uses the various data elements to categorize the tracts. For the BIPOC percentage by REII index, the average percentage of the population that is BIPOC in all tracts categorized as lowest, low, moderate, and high is 10%, 16%, 22% and 33% respectively compared to the state average of 20.

Table 2: Race/Ethnicity & Income Index Measures and Related Metrics Summary (2014-2018)

Data Category	Measure	Race/Ethnicity & Income Index				
		Lowest	Low	Moderate	High	Statewide
Socio-Demographic & Population	% People Living in Poverty	8%	12%	15%	23%	14%
	% BIPOC	10%	16%	22%	33%	20%
	Population	1,139,724	1,165,118	774,907	1,002,194	4,081,943
	Count of Tracts in Category	240	239	153	195	827
Pedestrian Injury	Fatal & Severe Injury Rate	12.8	15.5	27.0	35.7	21.9
	All Injury Rate	54.4	78.9	129.3	203.8	112.3
	Fatal & Severe Injury	146	181	209	358	894
	All Injuries	620	919	1002	2042	4583
	Average Fatal & Severe Injury	0.6	0.8	1.4	1.8	1.1
	Average Pedestrian Injury	2.6	3.8	6.5	10.5	5.5
Travel & Built Environment	Arterial VMT Density (Millions VMT per Sq. Mi)	493,726	634,285	1,052,054	1,459,501	865,363
	Miles of 45 MPH Roadway per 100 Sq. Mi	0.52	0.48	0.90	1.05	0.70
	Transit Stops per Sq. Mi	12	18	28	42	24
	% Household without Vehicle	3.7%	5.9%	8.2%	12.3%	7.2%
	Walk, Transit, and Bike Commute %	5.8%	9.0%	12.3%	16.3%	10.5%
	Alcohol Density (establishments per sq. mi.)	26.1	58.5	96.6	135.7	74.3

Pedestrian injury data and data summarizing the travel and built environment of the tracts are also summarized in Table 2. Fatal and severe pedestrian injuries, as well as all injuries, are included. Even though only 25% of the total state population lives in the tracts designated as High in the REII, 40% of the fatal and severe injuries and 45% of the total pedestrian injuries occur in those tracts. These pedestrian injury outcomes are also expressed as a rate normalized by the total population in the tract. These rates show that for both injury categories (fatal & severe/ all injuries) rates are significantly higher in Moderate and High REII categories.

The travel and built environment data summaries shed some light as to why these disparities in pedestrian injury outcomes may be occurring. Arterial vehicle miles traveled (VMT) density and miles of roadway with a posted speed limits of 45 miles per hour (MPH) or greater are shown in order to describe the vehicle travel exposure that people living and working in these tracts experience. The arterial VMT density is significantly higher in the tracts classified as High in the REII compared to the Lowest and Low REII categories and also higher than the statewide average. The number of miles high speed roadway is also higher in the Moderate and High REII tracts compared the Lowest and Low tracts. Together these measure of VMT and speed suggest that tracts designated as Moderate and High in the REII experience more arterial VMT and that VMT is typically higher speed compared to tracts in the other REII categories. These findings are consistent with other studies that areas with more arterial roads, higher speeds, and higher volumes are associated with more and higher severity pedestrian crashes. For example, prior studies have found that higher proportions of arterials (*20*), or more miles of arterial roads (*21–23*), were associated with more pedestrian crashes. Similarly, other studies have found that higher proportions of lower speed or local roads were associated with fewer pedestrian crashes (*24*, *25*). Higher average speeds have also been found to be associated with more pedestrian crashes (*23*, *26*, *27*) and /or increased injury severity (*23*, *28*). Higher average traffic volumes levels have also been found to be associated with more pedestrian crashes (*3*, *20*, *23*, *27*, *29–31*).

The number of transit stops, percent of households without a vehicle, and the percentage of workers using walk, bike, and transit to commute to work are summarized by REII in Table 2 to demonstrate that people living and working in these tracts are more exposed to the high volume, high speed traffic conditions. The number of transit stops is nearly double the state average in tracts designated as High in the REII, and nearly four times higher than in tracts classified as Lowest in the REII. Additionally, 16.3% of workers in tracts classified as High in the REII commute to work by walking, biking or using transit compared to just 5.8% in the Lowest category and 10.5% statewide. Lastly, the percentage of households without a vehicle in the High REII category is 12.3% compared to just 3.7% in the Lowest category and 7.2% statewide. Vehicle-less households are more likely to use other modes of travel such as walking and transit. Taken together these data summaries demonstrate the likely amount of pedestrian exposure in tracts within each of the REII categories. Tracts categorized as High in the REII have higher number of transit stops and workers using either walk, transit or a bike to commute meaning they are likely more exposed to vehicle traffic and contributes to higher numbers of pedestrian injuries in these tracts.

A key objective of this research seeks to know if pedestrian injury disparities are growing or shrinking. In order to measure these outcome changes over time, we use the REII approach to compare two separate period of data, including the 2008 to 2012 five-year period and the 2014 to 2018 five-year time period. Population based injury rates are calculated for each REII category the fatal and severe injury rates are shown in Figure 4 while the total pedestrian injury rates are shown in Figure 5.

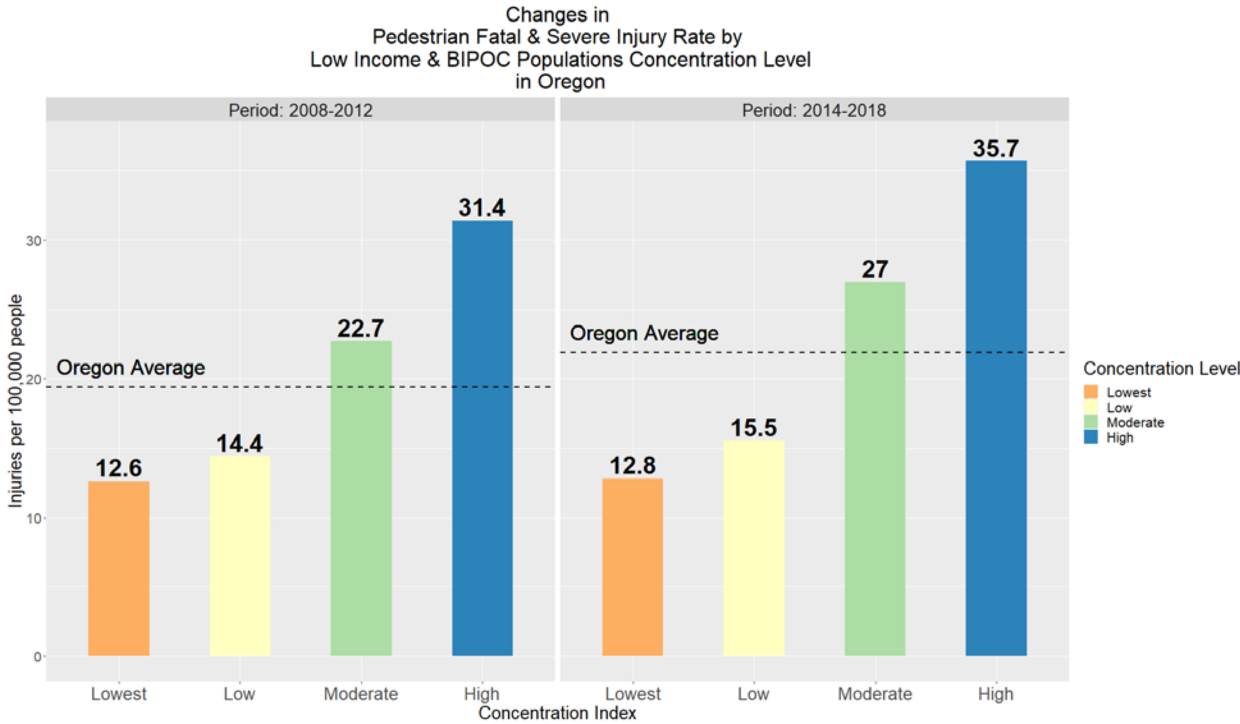

Figure 4: Pedestrian Fatal & Severe Injury Rate Period Comparison

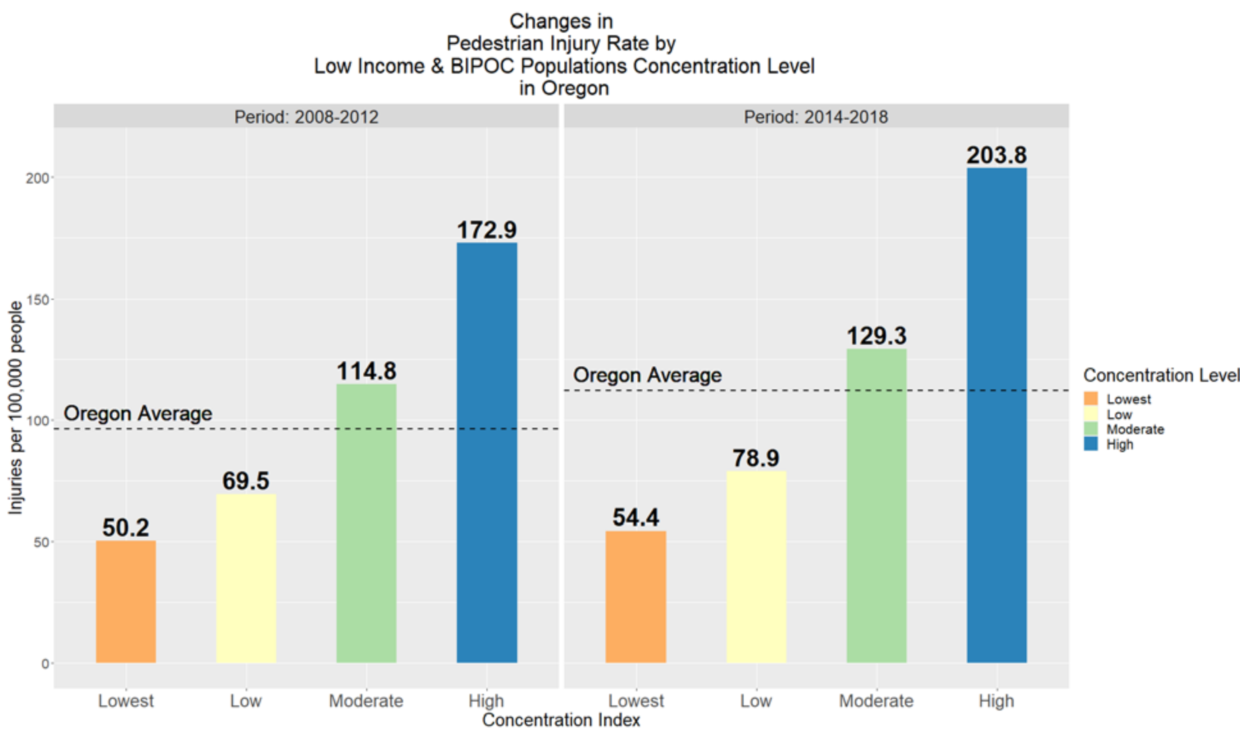

Figure 5: Pedestrian Total Injury Rate Period Comparison

Figure 4 and Figure 5 show that for all REII categories, and for both injury severity categories, the injury rate has increased over the two time periods. The rate of increase has not been equal across REII categories however, with the fatal and severe injury rate increasing by 14% in the High REII while the Lowest REII category only increased by 2%. For the total injury rate the tracts categorized as High REII increased by 18% while the Lowest REII tracts only increased by 8%. So even though the pedestrian injury rate grew across the state the increase was higher in High REII tracts compared to the Lowest REII tracts.

The analysis featured in this section informs the analysis in Chapter 7.0 that will use a variety of statistical analysis tools to better capture the effects of built environment, traffic exposure, race, ethnicity, and income on pedestrian injury outcomes. The results presented above show that tracts with higher concentrations of people of color and low-income people have higher rates of pedestrian injuries for all injury severities. Likely contributors to these disparate outcomes are that BIPOC communities and low-income communities have more exposure to high vehicle volumes moving at higher speeds. Based on the REII summaries above, people and workers in these High and Moderate REII tracts also travel by foot, transit, and bicycle at a higher rate which increases their exposure to the high volume, high speed roads. The analysis in Section Chapter 7.0 analyzes the relationships between the built environment, traffic exposure, race, ethnicity, and income to more precisely understand the role these factors play in pedestrian injury outcomes.

R code developed for this work can be used to create the measures included in this paper for any state. Data from Census and some other sources, like GTFS are available for all states though some data like alcohol establishment may need to be acquired or removed from the analysis. The code for the FARS rate analysis is available at https://github.com/JoshRoll/Pedestrian-Fatal_Injury_Rate while the code for calculating the index analysis is available at https://github.com/JoshRoll/Pedestrian-Injury-Disparity-Index-Analysis. These tools can be used for understanding baseline measures of pedestrian injury disparities and can inform the early stages of planning interventions.

DISCUSSION AND CONCLUSIONS

The approach used above to document fatal injury rates by race is relatively simple and easily reproducible for any state in the US and could be used in large regions since this method relies on FARS data and Census data which are available for all 50 states and Puerto Rico. From these data we can document that for Oregon, most BIPOC groups are over represented in the fatal pedestrian injury data.

To understand some of the likely pathways to these disparities a z-score analysis was performed that also uses mostly commonly available data including pedestrian injury counts (of all severities) and Census data, arterial roadway vehicle miles of travel and other network measures. This analysis demonstrated that in Census tracts with higher concentrations of people living in poverty and BIPOC populations, pedestrian injury rates of all severities are higher compared to the state average.

In the pedestrian fatality by race analysis using FARS data in Oregon, we found that pedestrian fatality rates for the most recent period of data show BIPOC Oregonians experience a higher burden of pedestrian injury compared to the state average. (2.8 deaths per 100,000 people for BIPOC compared to 2.1 deaths per 100,000 for all people in Oregon). Black Oregonians experienced the highest rate of pedestrian fatal injury followed by American Indian and Alaskan Native, Latinx, and Asian. Even more alarmingly, the pedestrian fatal injury disparities worsened between the periods ending in 2013 and 2018, with earlier periods of data exhibiting smaller disparities between BIPOC populations and the state average.

The race, ethnicity and income index analysis revealed that some Census tracts have significantly higher rates of poverty and BIPOC populations, and that those tracts tend to experience higher rates of pedestrian fatal and severe injury, as well as all injuries. Tracts categorized as High represent 25% of the state's population (1.002 million people) but 40% of the fatal and severe injuries and 45% of the total pedestrian injuries. The tracts with the highest concentrations of BIPOC and low-income Oregonians also experienced greater increases in pedestrian injury; the rates of pedestrian injury in tracts classified as Moderate and High have increased by 18% and 13% compared to 1% and 7% for tracts classified as Lowest and Low poverty and BIPOC population. The Index provides a window into factors that may be associated with these higher levels of pedestrian injury and fatality, including more vehicle miles travelled, more high-speed arterials, and more people needing to walk and take transit to get around.

The simplified analysis approach employed in this study reveal alarming pedestrian safety disparities by race and income, as well as evidence that the disparities are growing. The index also provides a way to explore other characteristics that may be associated with pedestrian crashes. For example, the index revealed that the areas with the highest concentrations of BIPOC and people living in poverty, as well as the higher pedestrian injury rates, also experience three times the arterial VMT density and twice the miles of 45mph plus roadways compared to the areas with the lowest concentrations of BIPOC and people living in poverty.

The analysis presented int his paper can serve as a starting point for understanding the existing disparities in pedestrian injuries in a state or region. These analyses techniques are less sophisticated then statistical modeling approaches but still yield easily comprehendible information to inform decision makers. These analyses can also serve to inform more advanced analysis such as network segment and intersection level safety performance function development. Ideally other states and regions can deploy these analyses techniques and help to better understand existing pedestrian injury disparities by race and poverty.

AUTHOR CONTRIBUTION STATEMENT

The authors confirm contribution to the paper as follows: study conception and design: JR; data collection: JR; analysis and interpretation of results: JR; NM; draft manuscript preparation: NM; JR. All authors reviewed the results and approved the final version of the manuscript.

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