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Examining racial bias as a potential factor in pedestrian crashes

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ABSTRACT

Introduction: In the US people of color are disproportionately affected by pedestrian crashes. The purpose of this study was to examine the potential for racial bias in driver yielding behaviors at midblock crosswalks in low and high income neighborhoods located in the sprawling metropolitan area of Las Vegas, NV.
Methods: Participants (1 white, 1 black female) crossed at a midblock crosswalk on a multilane road in a low income and a high income neighborhood. Trained observers recorded (1) number of cars that passed in the nearest lane before yielding while the pedestrian waited near the crosswalk at the curb (2) number of cars that passed through the crosswalk with the pedestrian in the same half of the roadway.
Results: The first car in the nearest lane yielded to the pedestrian while they waited at the curb 51.5% of the time at the high income and 70.7% of the time at the low income crosswalk. Two way ANOVAs found an interaction effect between income and race on yielding behaviors. Simple effects for income revealed that at the high income crosswalk, drivers were less likely to yield to the white pedestrian while she waited at the curb ($F(1,122) = 11.18; p = 0.001$), and were less likely to yield to the black pedestrian while she was in the same half of the roadway at the high income crosswalk ($F(1,124) = 4.40; p = 0.04$). Simple effects for race showed significantly more cars passed through the crosswalk while the black pedestrian was in the roadway compared to the white pedestrian at the high income crosswalk ($F(1,124) = 6.62; p = 0.01$).
Conclusions: Bias in driver yielding behavior may be one influencing factor in higher rates of pedestrian crashes for people of color.

1. Introduction

Pedestrian injuries are a significant public health issue in the U.S., accounting for over 4700 deaths and nearly 66,000 injuries in 2013. This equates to one death every two hours and one injury every eight minutes (National Highway Traffic Safety Administration, 2015). Pedestrians are overrepresented in the number of traffic fatalities; about 10% of all trips are made on foot, but pedestrians account for about 13% of all traffic fatalities (Benchmarking Report, 2014; Centers for Disease Control and Prevention, 2013).

People of color are disproportionately affected by pedestrian crashes. From 2001 to 2010 the pedestrian fatality rates for black and Hispanic men were more than twice the rate for white men, and American Indian/Alaska Native men had a rate more than 4 times higher (Centers for Disease Control and Prevention, 2013). Maybury et al. found that African Americans had 22% greater odds of mortality and Hispanics had 33% greater odds of mortality compared with whites after being taken to a hospital post pedestrian trauma (Maybury et al., 2010). Cottrill and Thakuriah (2010) reported that the number of pedestrian crashes in low income and high minority neighborhoods (termed environmental justice areas) were twice that of non-environmental justice areas (Cottrill and Thakuriah, 2010; Brown, 2016). Research of the Las Vegas, NV metropolitan area found similar disparities, with crashes being more likely to occur in low income neighborhoods and neighborhoods with a high percent Hispanic population (Pharr et al., 2013).

Driver yielding behaviors can be influenced by many factors. Sun et al. (2003) modeled pedestrian-driver interactions at an uncontrolled midblock crosswalk and found that drivers were more likely to yield to a group of pedestrians and if traffic in the opposing direction had already yielded. Additionally, older drivers were more

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likely to yield than younger drivers (Sun et al., 2003). Driver likelihood to yield has also been found to decrease if vehicles are traveling in a group (Schroeder and Rouphail, 2010). It is possible that yielding behaviors may have even been influenced by parental driving style (Taubman-Ben-Ari et al., 2005). Additionally, individual behaviors are complex and are likely influenced by personal factors such as the drivers personal politeness, roadway courtesy, and their own personal biases.

One potential explanation for such a disparity which is under studied is the influence of racial bias on driver yielding behaviors. Racial minorities experience differential treatment and discrimination through a variety of circumstances, including medical treatment, education, and the criminal justice system (Alegría et al., 2008; Solorzano and Yosso, 2001; Rashlinski et al., 2009). While people of color are disproportionately burdened with social inequalities, in many cases this biased treatment remains after controlling for such factors as income, insurance status, and educational level (Barr, 2014). It is important to understand if this bias is a potential contributing factor to the over representation of people of color in pedestrian crashes. Goddard, Kahn and Adkins conducted a controlled field trial in downtown Portland, OR at a midblock crosswalk (Goddard et al., 2014, 2015). Driver yielding behavior was observed as white and black pedestrian research participants waited at the marked crosswalk. They report that the average number of drivers that passed the black pedestrian without yielding was twice the average of drivers that passed the white pedestrian. This study aimed to contribute to the literature by conducting a similar examination of driver yielding behaviors in a sprawling metropolitan area and by including both high and low income neighborhood crosswalks in examination.

The examination of driver yielding behaviors in this study add to the findings of Goddard, Kahn and Adkins, as sprawl poses a unique threat to pedestrian safety. Research has found that pedestrian fatalities are higher in areas with urban sprawl, or a development pattern that consists of low density development with residential areas separated from retail and other uses that are connected by high speed streets (Paulozzi, 2006; Ewing et al., 2003). It is particularly important to understand factors associated with pedestrian injuries in Las Vegas, as the urban design is characteristic of sprawl, with single use development and numerous multi-lane arterial streets. In fact, Smart Growth America Ranked Las Vegas as the 13th most dangerous metropolitan area to be a pedestrian (of the 52 largest metro areas) in their 2014 report *Dangerous By Design* (Smart Growth America, National Complete Streets Coalition, 2014). This is actually a slight improvement from the 2011 report which ranked Las Vegas as 6th. For three consecutive years the number of pedestrian deaths in Nevada have increased. In March of 2016 the state declared an epidemic of pedestrian fatalities, with numbers up 46% from the same time period in 2015 (Brown, 2016). Additionally, pedestrian crash rates have been found to differ by neighborhood income (Cottrill and Thakuriah, 2010; Pharr et al., 2013; Christie, 1995). This study examined driver yielding behaviors at a low income and a high income neighborhood crosswalk.

Nevada state law is somewhat ambiguous as to when dr ivers are required to yield to pedestrians. The Nevada Revised Statutes (NRS 484B.283, 1969) states the following regarding the right of way in a crosswalk: "When official traffic-control devices are not in place or not in operation the driver of a vehicle shall yield the right-of-way, slowing down or stopping if need be so to yield, to a pedestrian crossing the highway within a crosswalk when the pedestrian is upon the half of the highway upon which the vehicle is traveling, or when the pedestrian is approaching so closely from the opposite half of the highway as to be in danger (NRS 484B.283, 1969)." This suggests that the pedestrian must be inside of the crosswalk for the driver to yield, implying that if they are waiting on the sidewalk adjacent to the crosswalk that the driver is not required to yield. However, it also states that drivers of motor vehicles must "Exercise proper caution upon observing a pedestrian: (1) On or near a highway, street or road... (3) In or near a ... marked or unmarked crosswalk (NRS 484B.280, 1969)." Can one safely assume that exercising proper caution means yielding to the pedestrian when they are near the crosswalk? Or is it only mandated that yielding occurs when the pedestrian is actually in the roadway? It is unclear. As a result, both scenarios were observed and recorded. The purpose of this study was to examine the potential for racial bias in driver yielding behaviors at midblock crosswalks in a low income neighborhood and a high income neighborhood in Las Vegas, NV.

2. Methods

Two midblock crosswalks were chosen on minor arterial streets, one in a higher income area of Las Vegas median household income = $55,994; mean household income = $80,289 (U.S. Census, 2014) and one in a lower income area (median household income = $32,884; mean household income = $49,100). The high income neighborhood street consisted of six vehicle lanes with a speed limit of 45mph, and the low income neighborhood had four vehicle lanes with a speed limit of 35mph.

Two research participants, one white female and one black female, acted as pedestrians attempting to cross the street at a midblock crosswalk. Both pedestrians were about the same height and build and, though they were not dressed identically, both pedestrians wore similar, neutral colored clothing. Research participants only crossed when no other pedestrians were present. All observations took place between 10a.m. and 12p.m. on a Saturday and a Sunday in Novermber 2015.

Each pedestrian completed approximately 30 crossing attempts at each of the two crosswalks. Pedestrians approached the crosswalk and waited on the sidewalk at the curb before entering the roadway. For the safety of the research participants, the roadway was not entered until they were sure that the oncoming vehicle in the nearest lane to the roadway was going to yield. This was determined by the pedestrian making eye contact with the driver and observing the speed of the vehicle as an impending stop. Participants indicated that they were intending to cross the roadway by waiting near the curb and facing oncoming traffic.

The pedestrian entered the crosswalk on the roadway when the nearest car stopped and yielded to the pedestrian. The pedestrian then continued the entire length of the road, taking caution to ensure that all oncoming traffic continued to yield. A trained observer recorded the (1) number of cars that passed in the nearest lane before yielding while the pedestrian waited near the crosswalk at the curb (2) number of cars that passed through the crosswalk with the pedestrian in the same half of the roadway (total cars that passed in the first half of the roadway while pedestrian was in that segment of the roadway summed with total cars that passed in the second half of the roadway while the pedestrian was in that segment of the roadway).

There were a total of 126 roadway crosses. The white pedestrian crossed 34 times at the high income crosswalk and 28 times at the low income crosswalk (2 attempts were removed from analysis due to a timer error which may have resulted in a flawed observation account) and the black pedestrian crossed 34 times at the high income crosswalk and 30 times at the low income crosswalk.

Two way ANOVA tests were conducted to examine if there was an interaction effect with income and race and to examine the main effects. Analysis was conducted in SPSS 22.

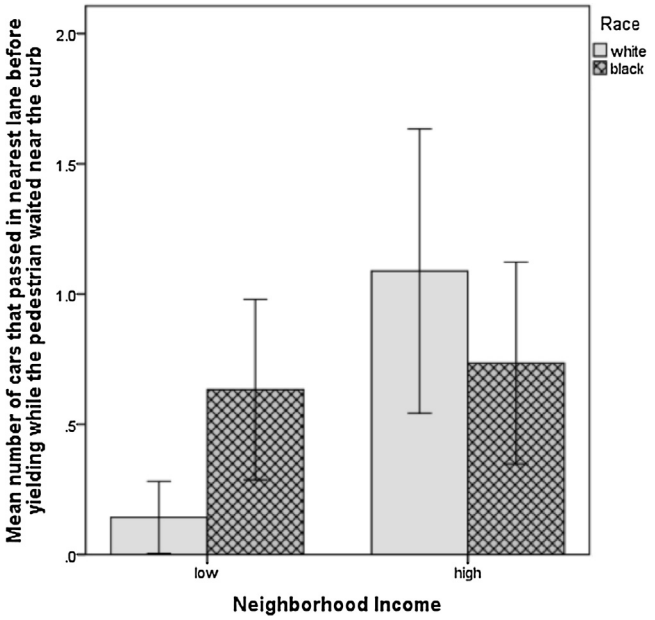

Fig. 1. Mean number of cars that passed in the nearest lane before yielding while the white and black pedestrian waited near the crosswalk at the curb at the high and low income neighborhood midblock crosswalks (bars represent 95% confidence intervals).

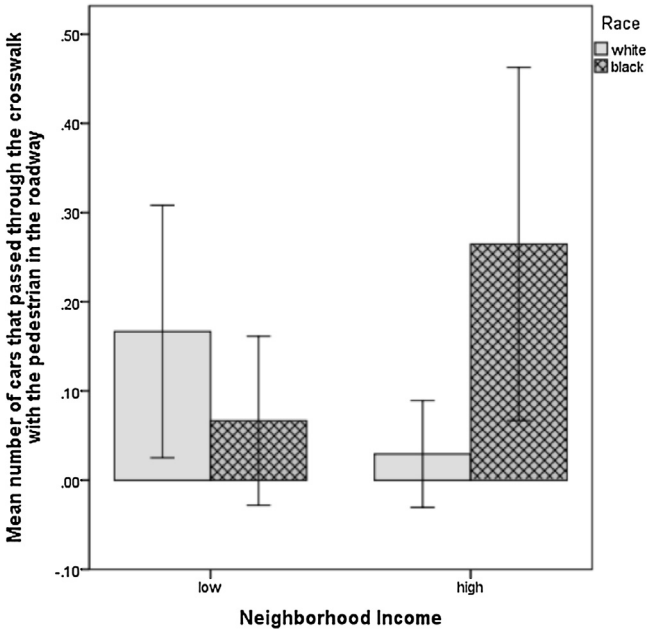

Fig. 2. Mean number of cars that passed through the crosswalk while the white and black pedestrians were in the same half of the roadway at the high and low income neighborhood midblock crosswalks (bars represent 95% confidence intervals).

3. Results

There were a total of 126 cars observed while the pedestrian waited near the crosswalk at the curb. There were 128 cars observed while the pedestrian was in the same half of the roadway.

3.1. Number of cars that passed in the nearest lane before yielding while the pedestrian waited near the crosswalk at the curb

The first car in the nearest lane yielded to the pedestrian while they waited at the curb 51.5% of the time at the high income and 70.7% of the time at the low income crosswalk. A two-way ANOVA was conducted that examined the effect of income and race on driver yielding behaviors. There was a statistically significant interaction effect between neighborhood income and race on the number of cars that passed in the nearest lane before yielding while the pedestrian waited near the crosswalk at the curb ($F(1,122) = 4.53$, $p = 0.03$). When examining simple effects for race there were no significant differences in yielding at the low income crosswalk ($F(1,122) = 2.84$ $p = 0.09$) or the high income crosswalk ($F(1,122) = 1.73$ $p = 0.19$). The simple effects for neighborhood income revealed that for the white pedestrian drivers were less likely to yield at the high income compared to the low income crosswalk ($F(1,122) = 11.18$ $p = 0.001$); there was no significant difference in yielding at the high income compared to low income crosswalk for the black pedestrian ($F(1,122) = 0.14$ $p = 0.71$) (see Fig. 1).

3.2. Number of cars that passed through the crosswalk with the pedestrian in the same half of the roadway

A two-way ANOVA showed that there was a statistically significant interaction effect between neighborhood income and race on the number of cars that passed through the crosswalk with the pedestrian in the same half of the roadway ($F(1,17.62) = 3.30$, $p = 0.01$). Simple effects for race showed significantly more cars passed through the crosswalk while the black pedestrian was in the roadway compared to the white pedestrian at the high income crosswalk ($F(1,124) = 6.62$ $p = 0.01$); there was no significant racial difference at the low income crosswalk ($F(1,124) = 1.06$ $p = 0.31$). Simple effects for income revealed that for the black pedestrian there were significantly more cars that passed through the crosswalk while she was in the roadway at the high income compared to the low income crosswalk ($F(1,124) = 4.40$ $p = 0.04$); there was no significant difference for the white pedestrian in the number of cars that passed through the high income compared to the low income crosswalk ($F(1,124) = 2.11$ $p = 0.15$) (see Fig. 2).

4. Discussion

Findings show that there may be a bias in driver yielding behavior in a sprawling metropolitan area, similar to Goddard, Kahn and Adkins' findings in downtown Portland (Goddard et al., 2014, 2015). However, findings of the current study revealed that the impact of race differed in high and low income neighborhoods. Given the study methodology, drivers were merely observed and no interaction took place regarding their decisions to yield or not yield. Therefore, we are unable to determine the nature of the bias.

These findings are significant for pedestrian safety overall in that drivers yielded less often in general on the high income neighborhood street. One potential explanation may be that drivers are not as accustomed to observing pedestrians crossing in the high income neighborhood compared to the lower income neighborhood, as higher income individuals are more likely to travel by private vehicle (U.S. Census, 2014). The authors can only speculate on this, however, as overall pedestrian traffic in each neighborhood is unknown. Another factor for overall less yielding in the high income neighborhood may be the difference in road design, as the high income neighborhood street consisted of more vehicle lanes and a higher speed limit (45 mph compared to 35 mph). The higher speed of travel may make it more difficult to observe and yield to pedestrians in a timely manner. It is unknown if yielding differences would have persisted if this was not the case. This phenomenon should be further explored, as if it is the case, placing midblock crossings on streets with a 45 mph speed limit may place pedestrians at an increased risk, regardless of driver bias.

When comparing yielding behaviors at the high and low income crosswalks, more cars passed in the nearest lane without yielding while the white pedestrian waited at the curb, and more cars passed through the crosswalk while the black pedestrian was in the same half of the roadway at the high income crosswalk. While the failure to yield places all pedestrians at risk, failing to yield while a pedestrians is in the roadway has greater safety implications than failing to yield while a pedestrian is still waiting at the curb. This is a significant finding, as it may be a factor in the increased pedestrian crash rates for minority populations. Residents of minority neighborhoods and people of color are more likely to experience higher levels of pedestrian crashes and pedestrian fatalities (Centers for Disease Control and Prevention, 2013; Cottrill and Thakuriah, 2010; Pharr et al., 2013). They are also more likely to report lower perceived safety of intersections and crossings than residents of neighborhoods with fewer people of color. This study and one conducted in Portland, OR (Goddard et al., 2014, 2015) suggests that reported higher perceived danger may be due to the lack of driver yielding behaviors.

This study is not without limitations. The primary limitation within this study was selecting equivalence at research sites. Finding midblock crosswalks in areas with equal density of traffic, pedestrian, and other road users and comparable intersections on similar road types but in economically opposed neighborhoods proved difficult. Assessing the number of vehicles passing the pedestrian waiting to cross was highly dependent on traffic patterns and influenced the number of crossings made by researchers. Yielding behaviors of drivers may be influenced by the drivers themselves, and given the nature of the study, no measures were taken about the drivers (ie: age, gender). Additionally, one can not assume that drivers in either the high income or low income neighborhood were residents of that particular neighborhood. Expanding participant diversity from solely racial differences to age and gender variables may add nuance to results. Lastly, the expansion of this study to multiple low and high income crossing sites may generate more significant findings.

4.1. Public health implications

Implementation of policy must begin with respect for equitable use of roadways for all users. Findings of the current study demonstrated driver behaviors that could pose danger for pedestrians and national data shows that pedestrians are over represented in the proportion of roadway fatalities (Benchmarking Report, 2014; Centers for Disease Control and Prevention, 2013). Many current roadway designs are centered on automobile transportation and do not facilitate natural behaviors of other road users, specifically communities with high amounts of sprawl (Paulozzi, 2006; Ewing et al., 2003). Las Vegas offers a unique opportunity to transform suburban sprawl to a more connected, safe, and accessible road system through implementation of a well-developed Complete Streets Program.

The Complete Streets Model suggests the development of a broad coalition between urban planners, businesses, state and local and governments, as well as residents to ensure the use of appropriate designs that support safety and commerce. It is a policy effort intended to increase safety for both motorized and non-motorized street users through a variety of built environment changes (Smart Growth America, 2016). These changes may include lower speed limits, dedicated bike lanes, and safer street crossings, but studies indicate that neighborhoods with higher income and fewer minority residents are more likely to experience the benefits of Complete Streets changes than low income, high minority neighborhoods (Morency et al., 2012). Additionally, neighborhoods of lower socioeconomic status have higher rates of non-automobile transportation while also offering pedestrians, cyclists, and mass transit users fewer roadway safety controls. Given that the current study found significant interactions with race and neighborhood income, Las Vegas may benefit dually from a complete street policy while offering protections to all road users through improved urban design.

5. Conclusion

This study found differences in driver yielding behaviors in a sprawling metropolitan area in both high income and low income neighborhoods. Drivers were less likely to yield to the white pedestrian at the high income crosswalk while they waited at the curb and less likely to yield to the black pedestrian while they were in the roadway. While the lack of driver yielding behavior is of concern overall, failing to yield while the pedestrian is in the roadway may have greater safety implications than failing to yield while the pedestrian is still on the sidewalk. Policies, such as a Complete Streets Policy, and environmental modifications to enhance pedestrian safety are warranted.

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