EVIDENCE-BASED TRAFFIC ENGINEERING MEASURES TO REDUCE PEDESTRIAN MOTOR VEHICLE COLLISIONS: A REVIEW

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ABSTRACT

We offer a short critical analysis and assessment of engineering changes to the built environment that may decrease pedestrian injury risk. We conducted our research using the Transportation Research Information Services database to look for studies on engineering countermeasures that had been published in the scientific literature. We divided countermeasures into three categories: speed regulation, pedestrian separation from vehicles, and methods to improve pedestrian visibility and conspicuity. We identified the methods and settings that have the highest potential for preventing crashes. Our evaluation found that altering the built environment may significantly decrease the probability of pedestrian–vehicle collisions, with an emphasis on research with acceptable methodological methods.

KEYWORDS: *Controlled Intersection, Roadways, Traffic Engineering, Vehicle Collision, Vehicle Accident.*

1. INTRODUCTION

Pedestrian collision injuries continue to be a significant public health issue, despite declining rates of pedestrian deaths most notably among youngsters and the elderly. Each year, 80000 to 120 000 pedestrians are wounded in motor vehicle accidents in the United States, with 4600 to 4900 pedestrians dying **[1].** Pedestrians account for 11% of all motor vehicle fatalities, and they account for approximately 35% of fatalities in cities with populations over 1 million. The greatest population-based injury rate is among children aged 5 to 9, and the highest population-based mortality rate is among individuals over 80 years old. At junctions, people over the age of 65 are more likely to be hit than younger pedestrians **[2].** Alcohol consumption among pedestrians who have been harmed has been widely established. Modifications to the built environment, enforcement of traffic safety regulations, motor vehicle design modifications, and pedestrian education are all major methods to creating a framework for preventing pedestrian injuries.

In Europe, where pedestrians and cyclists account for roughly 20% of all fatalities on the road, modifying car fronts and other vehicle features to reduce the severity of injuries to pedestrians is a priority; however, despite research showing potential benefits, this approach has not been prioritized in the United States **[3].** Pedestrian education is a popular strategy, although there is little evidence that it works, save for youngsters. The modification of the built environment is a common and successful strategy. We conducted a comprehensive assessment of traffic engineering remedies that have been shown successful in decreasing the probability of pedestrian accidents in the scientific literature. The Transportation Research Information Services (TRIS) database of the National Academy of Sciences served as the main search engine. TRIS is the biggest and most complete bibliographic database on transportation information in the world. Many studies of traffic engineering measures have methodological problems, including as failing to account for regression to the mean when treating high-crash sites and relying on simple before–after data without adequate controls **[4].**

We included papers in our evaluation to the degree feasible based on appropriate scientific criteria, such as the use of comparator sites to account for confounding variables. Only limited assessments with less trustworthy methods were available for a number of potential remedies. Failure to account for regression to the mean is a frequent flaw in many crash-based before-and-after assessments of traffic engineering countermeasures, which may lead to overestimation of the benefits of an intervention when treatment locations are chosen because they have had a large number of accidents **[5].** Regression to the mean may be partly addressed by selecting comparison sites with comparable features, but not entirely. We included some papers in our evaluation that had methodological flaws; in these instances, we noted the limitations.

Because accidents are uncommon occurrences and conflict studies offer information about possible crash causes, some researchers performing observational road safety studies analyze pedestrian–motor vehicle disputes instead of crash data to assess roadway countermeasures. Conflicts are “near-miss” situations in which a vehicle must suddenly stop or swerve to avoid hitting a pedestrian, or a pedestrian must take rapid evasive action to prevent being struck. The accuracy of utilizing conflicts to predict accidents. On the basis of empirical data, statistical techniques to assess the validity of traffic conflicts **[6]**. If the anticipated number of crashes is fewer than, it can be demonstrated that a 1-day conflict count gives a more accurate estimate of the expected number of crashes than a 1-year crash history. Regression to the mean associated with remediation of high accident sites is not a factor in conflict studies or other short-term before–after assessments of road user behavior. The following is a list of the most important engineering methods for reducing vehicle speeds. Speed control seems to have the most promise for injury prevention in residential settings with a high number of youngsters.

The majority of pedestrian accidents involving children are caused by the child's mistake. Slower speeds allow drivers more time to respond and may reduce injuries in the event of a collision. Slower speeds are preferable in pedestrian-heavy regions since many young children fail to stop before crossing the street. It is estimated that 69 percent of child pedestrian accidents occur in the middle of the block, when youngsters dash into the roadway. Vehicle distance and velocity are difficult for young toddlers to judge. In this post, we'll take a look at some of the technical changes that may be made to the built environment to lower the likelihood and severity of pedestrian injuries **[7].** Pedestrians have been mostly neglected or given just a passing thought in the construction of much of the country's highway infrastructure. It may be difficult for cars and pedestrians to properly use the road when the built environment places a low emphasis on pedestrians. Vehicle pedestrian collisions may be reduced by modifying the built environment. Separation of pedestrians from vehicles by time or distance, steps to improve pedestrian visibility and conspicuity, and decreases in vehicle speeds are the three main types of engineering changes. Pedestrian separation tactics minimize the risk of injury to pedestrians on the roadside as well as while crossing roadways **[8].**

Because many pedestrian accidents are claimed to occur because the vehicle did not notice the pedestrian before the collision, pedestrian visibility and conspicuity must be improved. Higher vehicle speeds are linked to a higher risk of pedestrian collisions and more severe pedestrian injuries **[9].**The most successful speed control intervention found in terms of accident reduction was the construction of contemporary roundabouts in lieu of traditional junctions. Roundabouts have two operational and design principles: yield at entrance, which compels incoming traffic to give way to cars in the circle, and deflection of entering traffic, which causes vehicles to enter at a low speed **[10].**

2. DISCUSSION

Modification of the built environment, enforcement of traffic safety regulations, motor vehicle design modifications, and pedestrian education are all major methods to creating a framework for preventing pedestrian injuries. In Europe, automobile fronts and other vehicle characteristics are being modified to minimize the severity of pedestrian injuries. Pedestrians have been largely disregarded or given little thought in the construction of most of the country's highway infrastructure. When pedestrians are given low priority in the built environment, it may be difficult for cars and pedestrians to properly use the road. Vehicle–pedestrian collisions may be reduced by making changes to the built environment. Separation of pedestrians from vehicles by time or space, methods to enhance pedestrian visibility and conspicuity, and vehicle speed reductions are the three main types of engineering changes. Pedestrian separation tactics minimize pedestrian exposure to possible injury on the roadside and while crossing roadways.

Because many pedestrian accidents are claimed to occur because the motorist did not notice the pedestrian before the collision, efforts to improve pedestrian visibility and conspicuity are required. Higher vehicle speeds are significantly linked to an increased risk of pedestrian collisions as well as more severe pedestrian injuries. We conducted a comprehensive assessment of traffic engineering remedies that have been shown successful in decreasing the probability of pedestrian accidents in the scientific literature. The Transportation Research Information Services (TRIS) database of the National Academy of Sciences served as the main search engine. Many studies of traffic engineering measures have methodological problems, including as failing to account for regression to the mean when treating high-crash sites and relying on simple before–after data without adequate controls. We included papers in our evaluation to the degree feasible based on appropriate scientific criteria, such as the use of comparator sites to account for confounding variables. Only limited assessments with less trustworthy methods were available for a number of potential remedies.Failure to account for regression to the mean is a frequent flaw in many crash-based before-and-after assessments of traffic engineering countermeasures, which may lead to overestimation of the benefits of an intervention when treatment locations are chosen because they have had a large number of accidents.

Regression to the mean may be partly addressed by selecting comparison sites with comparable features, but not entirely. We included some papers in our evaluation that had methodological flaws; in these instances, we noted the limitations. Because accidents are uncommon occurrences and conflict studies offer information about possible crash causes, some researchers performing observational road safety studies analyze pedestrian–motor vehicle disputes instead of crash data to assess roadway countermeasures. Conflicts are “near-miss” situations in which a vehicle must suddenly stop or swerve to avoid hitting a pedestrian, or a pedestrian must take rapid evasive action to prevent being struck. According to European research, changing traditional junctions to roundabouts may decrease pedestrian accidents by approximately 75 percent on average. Single-lane roundabouts, in particular, have been shown to have much lower pedestrian accident rates than similar traffic-light junctions. Traffic calming and multiway stop sign control are two more methods for reducing speed. Lane narrowing, changes in highway curvature, pedestrian refuge islands, and speed humps are all examples of traffic calming methods. Despite the fact that traffic calming techniques are demonstrably successful in reducing traffic speeds. The impact on pedestrian-vehicle collisions is less clear. According to one research of "extensive" area-wide traffic calming measures that used a before–after design without controls, pedestrian–vehicle accidents reduced by 25% after these measures were implemented.

A recent assessment of controlled before–after studies of area-wide traffic slowing, on the other hand, found no overall impact on pedestrian–vehicle accidents. Pedestrian collisions were reduced by 25% when multiway stop signs were installed in place of traffic signals at low-traffic volume urban intersections, according to an investigation focusing on multiway stop sign control, which produces low vehicle speeds near intersections compared to traffic signal control or conventional 2-way stop signs. The following is a summary of engineering methods designed to segregate people and automobiles based on time. These treatments have mostly been studied for their impact on road user behavior and pedestrian–vehicle interactions, rather than accidents, and their use is rather site dependant. According to one research, the installation of traffic signals significantly decreased confrontations at high-speed junctions where there were previously no signals and people had difficulties crossing. Exclusive traffic signal phasings, which halt all vehicle traffic for part or all of the pedestrian crossing signal, have been proven to decrease conflicts at junctions with traffic lights. According to a study comparing junctions with and without exclusive pedestrian signal phasings, the probability of pedestrian vehicle collisions at intersections with exclusive timing was about half that of intersections with conventional pedestrian signals.

At traffic lights, properly timed yellow and all-red clearing signals are required to guarantee that vehicles have enough time to clear the junction before pedestrian walk signals are shown. According to one research, changing the length of yellow and all-red signal timing together decreased the incidence of pedestrian and bicycle accidents at crossings by 37% when compared to control locations. Automatic pedestrian detection, which may be used at traffic lights instead of pedestrian push buttons to identify pedestrians and display a walk signal, has been shown to decrease confrontations substantially. This technology may also prolong crossing times to enable slower pedestrians to complete their journey. A walking pace of 1.0 m/s second is suggested at junctions with traffic lights and large numbers of senior walkers. At junctions with traffic lights, traffic signs and pavement markings that urge pedestrians to check for possible conflicts have also been proven to be beneficial.

Furthermore, studies have shown that in-pavement flashing lights that were triggered automatically by the presence of pedestrians and designed to encourage vehicles to yield to pedestrians decreased vehicle speeds and confrontations at uncontrolled crossings. The following is a list of engineering methods that are used to separate people and automobiles in terms of space. There were a number of very successful treatments discovered. Overpasses and underpasses may significantly decrease pedestrian conflicts and accidents. However, because to the expensive expense of such facilities, they can only be placed in a few places for example, at extremely broad crossings with high traffic speeds. When pedestrians are hesitant to utilize such facilities due to security concerns or difficult entry locations, the safety benefits may be restricted. In residential areas, sidewalks may help to decrease the danger of pedestrian collisions. Pedestrians may cross in two phases on refuge islands in the medians of two-way roadways, making the crossing process easier. This is particularly beneficial for pedestrians who stroll at a slower pace. Refuge islands reduce conflict, and multilane highways with elevated medians have substantially lower pedestrian accident rates than roads without such medians. Curb extensions of the sidewalk toward the street at the crosswalk, roughly the width of a parked car may also be utilized to shorten crossing distances.

Barriers and fences, which direct pedestrians to safe crossing locations and prevent them from rushing into traffic, have been shown to lower midblock crossings and accident rates significantly. Relocating stop lines farther back from crosswalks is a low-cost solution at signal-controlled junctions. As a consequence, cars pull back farther from crosswalks, increasing the distance between pedestrians and automobiles. The following is a list of engineering measures intended to improve pedestrian visibility and conspicuity. Increased roadway illumination intensity may help walkers see better at night, when more than half of all fatal pedestrian collisions occur. Increased highway illumination intensity at pedestrian crossings has been linked to a substantial decrease in nighttime pedestrian collisions.

Parking restrictions may be effective because parked cars block the view of pedestrians and drivers. On residential streets, the number of parked cars was the greatest risk factor in a case control study of child pedestrian injuries. Removal of on-street parking and adoption of diagonal parking, which forces cars to park at an angle to the curb usually approximately 30 degrees in the direction of traffic flow, are examples of parking limitations. Diagonal parking places pedestrians in the roadway at an angle that forces them to gaze in the direction of vehicles. Diagonal parking has been proven to decrease the amount of pedestrians accessing the roadway in front of a parked car when compared to parallel parking. Furthermore, by reducing the number of people that join the highway in front of a stopped bus, moving bus stops from the near side to the far side of junctions may improve pedestrian visibility and conspicuity. At signal controlled intersections, bus stop relocation has been found to substantially reduce the proportion of pedestrians who join the traffic in front of a stopped bus. Although crosswalk pavement markings are frequently employed in the hopes of decreasing pedestrian accidents, research shows that they are generally useless and, in some cases, even detrimental.

3. CONCLUSION

Pedestrian collisions are complicated occurrences that vary greatly in terms of the age of the pedestrians involved and the circumstances surrounding the collision. Modification of the built environment may significantly decrease the incidence of pedestrian vehicle collisions, according to our assessment of existing research, highlighting those with acceptable methodological approaches. Given the limited resources available for road engineering and the vast number of roads, the particular countermeasures and settings with the highest potential for accident avoidance must be prioritized. Single-lane roundabouts, sidewalks, exclusive pedestrian signal phasing, pedestrian refuge islands, and enhanced highway illumination intensity are all very effective remedies. Other countermeasures, including as advance stop lines, in-pavement flashing lights, and automated pedestrian identification at walk signals, have been tested on a smaller scale but have shown promise. Many traffic engineering solutions need more conclusive study to determine their impact on pedestrian vehicle accident hazards.

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