The Relationship between Pedestrian Deaths and Metropolitan Areas with High Density Vehicle Use

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Abstract:

The purpose of this paper is to determine if any relationship exists between pedestrian deaths and metropolitan statistical areas with high-density vehicle use. The motivation for doing this research is that the percentage of people walking to and from their destinations has decreased steadily over the years, yet pedestrian deaths have gone up from 4,843 in 2000 to 4,955 in 2001. This is the first increase in pedestrian deaths since 1995. Approximately 78,000 pedestrians were injured in traffic accidents during each of those two years. Because only 5% of all trips arc made on foot and about 12% of all traffic deaths arc pedestrians, walking is one of the most perilous modes of transportation (Kaldenbach, 2004). This paper will ask the following questions: what is the relationship between pedestrian death rate and characteristics of cities, such as population and motor vehicle density, pedestrian danger index (a measure of the average yearly pedestrian fatalities per capita, adjusted for the number of walkers, the number of walkers acts as a measure of exposure to the risk of being killed as a pedestrian), the percentage of people walking to work (determined by Census Journey-to-Work data, which provides information only on the mode people choose most often to travel to and from work), and street design?

Keywords: pedestrian safety | motor vehicle density | metropolitan transportation | pedestrian death rate

Article:

1. INTRODUCTION

The purpose of this paper is to determine if any relationship exists between pedestrian deaths and metropolitan statistical areas with high-density vehicle use. The motivation for doing this research is that the percentage of people walking to and from their destinations has decreased steadily over the years, yet pedestrian deaths have gone up from 4,843 in 2000 to 4,955 in 2001. This is the first increase in pedestrian deaths since 1995. Approximately 78,000 pedestrians were injured in traffic accidents during each of those two years. Because only 5% of all trips arc made on foot and about 12% of all traffic deaths arc pedestrians, walking is one of the most perilous modes of transportation (Kaldenbach, 2004). This paper will ask the following questions: what is the relationship between pedestrian death rate and characteristics of cities, such as population and motor vehicle density, pedestrian danger index (a measure of the average yearly pedestrian fatalities per capita, adjusted for the number of walkers, the number of walkers acts as a measure of exposure to the risk of being killed as a pedestrian), the percentage of people walking to work (determined by Census Journey-to-Work data, which provides information only on the mode people choose most often to travel to and from work), and street design?

In the U.S., pedestrian accidents are primarily an urban issue (Martinez and Porter, 2004). Many researchers today believe the major reason for pedestrian deaths is the amount of vehicle use in metropolitan areas (Kaldenbach, 2004). Some researchers have pointed out that newer roads built in metropolitan areas are built for autos, not for pedestrians (Erost, 2002). Wide roads, speeding traffic, and lack of crosswalks or sidewalks can all make walking a deadly activity. Related to these are arguments regarding the lack of government investment to improve the safety of all pedestrians from crime and motor vehicles (Sparta, 2004).

These issues can be linked to the overall urban environment and its influence on pedestrian safety. Crowded, densely developed cities in which many people walk to work or for shopping can be expected to have higher overall pedestrian accident rates. However. in recent decades, American cities have become dispersed, and have spatially expanded at a faster rate than their population has grown. These low-density cities are also highly dependent on cars, with more limited pedestrian facilities, and so can be expected to have less safe streets. These low density cities are more likely to be spread out due to urban sprawl which causes the streets to be less safe due to more automobiles and faster roads (Ewing et al., 2004).

2. LITERATURE REVIEW

Several approaches to pedestrian safety are apparent, ranging from improved safety signs and electronic signals to attempts at better understanding pedestrian behavior, and their responsibility in accidents (for example Hine, 1996; Keegan and O'Mahony, 2003). For example, in the U.S., pedestrian deaths are a major concern mainly for children and the elderly, and have a disproportionate impact on the poor (Dowswell and Towner. 2002). At the individual level, intoxication is one of the most important contributors to pedestrian death. Although reasons for the higher proportion of deaths involving intoxicated pedestrians are unclear, 60% of fatally injured intoxicated pedestrians have BACs greater than or equal to 0.20 g/dL, twice the legal limit for drivers in most states (Mittmeyer, 1999). Although these numbers are startling, they do not entirely explain the main factor of this phenomenon. In addition, focusing on pedestrians ignores the importance of urban structure and the nature of the automobile dominated urban transport system (Whitelegg, 1987).

Another area of study that has received much attention is that of the roadways: how they are built and how they are used? Mittmeyer (1999) notes that of the 1,088 deaths in urban areas in 1992 where posted speed limits and land uses were known, 73% occurred on roadways with a posted speed limit of either 30-35 mph (40%) or 40-50 mph (33%). Most deaths in urban areas occurred either on major streets and highways (57%) or on interstates and freeways (25%). Ernst (2002) adds that many state departments of transportation often choose to build roads that tum out to be dangerous for pedestrians. The deadliest roads tend to be high-speed arterials, with few accommodations or protections for pedestrians. US I9 in the Tampa-St. Petersburg-Clearwater metro area, the wad with the highest overall fatalities, is a six to eight lane principal arterial with a speed limit of 45mph. It has few sidewalks or crosswalks, and is lined by strip malls and big box stores set far back from the street. Although designed for access via automobile, people do walk on this street and an average of 11 pedestrians die on this stretch of road each year.

The Pedestrian Danger Index identifies the ten most dangerous metro areas for pedestrians (Ernst, 2002). This is a measure of the average yearly pedestrian fatalities per capita, adjusted for the number of walkers. Of the 9,649 pedestrians killed between 2000 and 2001, for which the location was known, nearly 45% were killed where no crosswalk was available. Another 19% were killed where crosswalk availability was unknown. Neighborhood streets, where we walk and our children play, claimed 69% of the 5,157 fatalities in 1996 (Doswell. 2(102). Sprawling southern and western communities built after World War II may be the most perilous because they were designed principally for motor vehicles.

These issues point to the lack of government funding and support for pedestrian facilities. In an ideal world, pedestrians would receive an equal level of respect and funding given to all other modes of transportation. Unfortunately that is not the case. Government statistics actually show that walking is the most dangerous mode of transportation per mile traveled (Minerd, 1999). Sparta (2004) reports that only recently have pedestrian and bicycle pathways been viewed by the Atlanta Regional Commission as one of the five major transportation systems in the Regional Transportation Plan. This is the case in many other cities. Transportation officials have even been removing marked crosswalks on the grounds that they provide pedestrians with a "false sense of security." Yet once crosswalks are removed, pedestrians are left to fend for themselves.

Because state Departments of Transportation typically control the vast majority of federal funds, federally funded roads have tended to be designed and built with little regard to local needs (Ernst, 2002). These often result in high speed arterials running through towns and neighborhoods, which in more sprawling urban places are also usually associated with the location of most shopping centers and services. Many areas also have curvilinear street patterns with low connectivity, increasing walking trip distances and forcing pedestrians along major streets, creating additional risk for pedestrians.

These mechanisms are all potential factors for pedestrian death rates. However, rather than focusing on individual road features or the actions of government agencies, the built form of cities may also be responsible. Since the end of the Second World War. the amount of urban space devoted to automobiles has increased greatly, so much so that by the 1970s more than 60% of the land area of many big city downtowns was devoted to automobiles (Horvath, 1974). In cities this level of automobile dominance can surely be expected to present increased hazards to those not in cars. In present day urban places where destinations arc not concentrated in downtown areas the whole area of the city is dominated by automobiles, giving pedestrians fewer safe places to walk (Southworth, 1997).

However, recent urban growth processes include very low population densities and dispersed development far from traditional downtowns (Ewing et al., 2004). This has been accompanied by an increase in reliance on the automobile to the exclusion of other modes. Because of changing street designs, there is less possibility of walking to destinations, and because of decreased land use diversity, there is less likelihood that there will be anyplace nearby to walk to. In such cities vehicular hazards to pedestrians may be greater than. in older and denser cities. It is interesting that the Southeast includes not only a number of highly dispersed cities but also ten of the fifteen highest metropolitan pedestrian death rates. Residents of these low density cities must drive longer distances, and households are more likely to have more personal cars (Weber and Sultana, 2005). This supports the expectation that MSAs with a higher dependence on vehicle use will have a higher pedestrian death rate.

3. DATA AND STUDY AREA

Is there a correlation between pedestrian death rates and MSAs with high populations or high rates of vehicle use? The importance of this question is significant given that there is little or no research or literature on this relationship. With correlation analysis and data from several sources we examine this question. with the goal of identifying whether relationships can be observed at the metropolitan level between pedestrian safety and measures of urban form. The PDR or pedestrian death rate is the dependent variable. This is the average annual pedestrian deaths per 100,000 people. The Pedestrian Danger Index is the average of the yearly pedestrian fatalities per capita, justified by the number of walkers (Ernst, 2002). Car density is found by dividing the total number of motor vehicles by the number of workers, and shows the dominance of automobiles in commuting in each city. Land use mix and street connectivity were also included, with the expectation that homogenous land uses and poorer street connectivity would be associated with higher death rates. Residential density shows the population concentration of the cities, while the sprawl index shows the overall compactness of cities (Ewing, 2004). As discussed above, the relationships between these and pedestrian fatalities is open to question. Denser and more compact cities could be expected to have higher rates. but because of suburbanization. this could also be expected of lower density cities.

For this research 19 MSAs for which the PDI and PDI were available were used (Fig. 1). Data were obtained from the US Census Bureau 2000 Summary File 3 to calculate vehicle and residential densities. The Census Bureau data consisted of the total vehicles owned by workers over the age of 16 and the total amount of people who drive to work. Data for the death rates by traffic accident in the top 50 metropolitan statistical areas, pedestrian death rates, the pedestrian danger index, and the percentage of people who walk to work were taken from Ernst (2002). Values for the sprawl index, land use mix, and street connectivity came from Ewing (2004).

4. FINDINGS AND DISCUSSION

Two figures were drawn to see if there is a relationship between the pattern of pedestrian death rate (Fig. 1) and car density (Fig. 2) by MSA. Figure 1 shows pedestrian death rates in the 19 MSAs. Higher rates are apparent in Tampa Bay, Orlando, and Jacksonville, FL. These are all cities in the top 5 for most dangerous streets (Ernst, 2002). Figure 2 shows car densities, which appears to have an inverse relationship with pedestrian death rates.

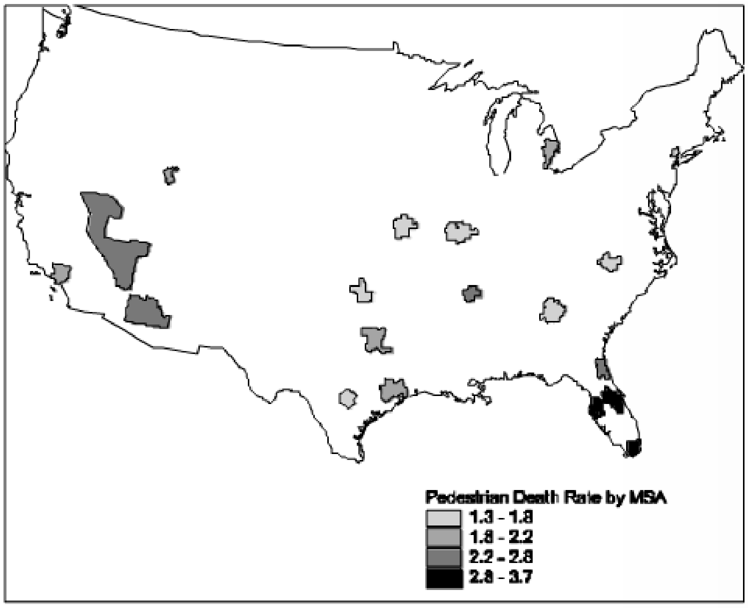

Figure 1. Pedestrian Death Rate by Selected Metropolitan Areas, 2000

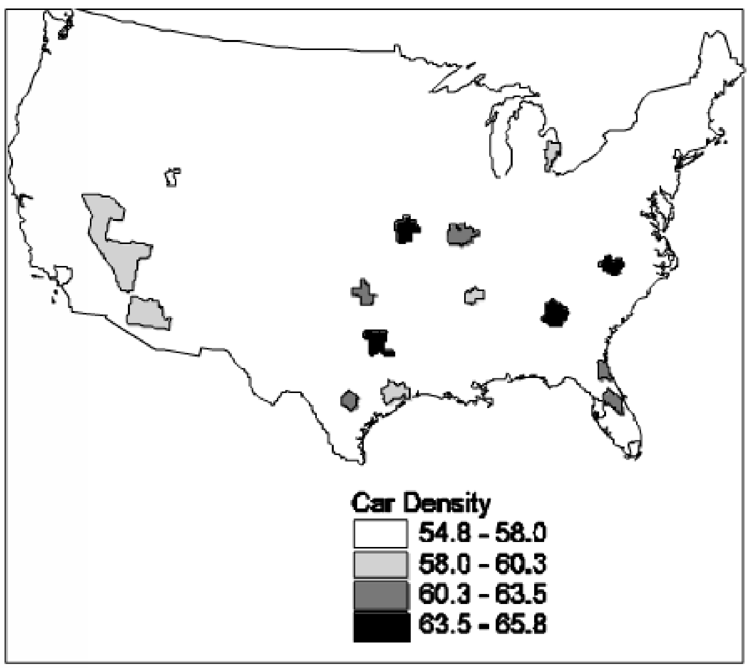

Figure 2. Car Density (x100) by Selected Metropolitan Areas, 2000

Scatter plot graphs representing the pedestrian death rates (peddeth) in correlation to the pedestrian danger index, percent of people who walk to work and car density were created. Spearman's correlation coefficient was used to see if there were any significant correlations between these variables.

Figure 3 is a scatter plot graph showing the relationship between pedestrian death rates (dependent variable) and the percent of people who walk to work (independent variable). There seems to be a positive linear correlation between these two variables, with higher pedestrian death rates associated with higher percentages of people walking to work.

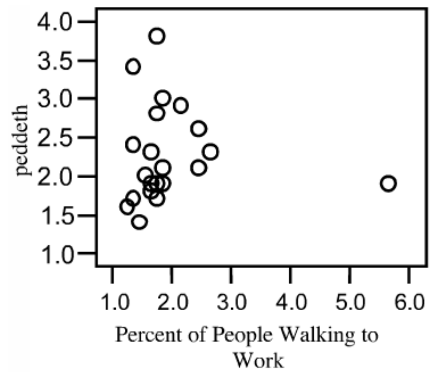

Figure 3. The Relationship Between Pedestrian Death Rates and Percent of People Walking to Work

In Figure 4, a scatter plot is presented showing the pedestrian death rate in relation to the pedestrian danger index. Figure 4 shows a positive linear relationship between these two variables with few outliers.

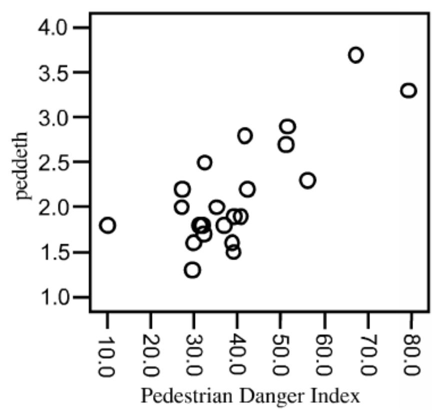

Figure 4. The Relationship Between Pedestrian Death Rates and Pedestrian Danger Index

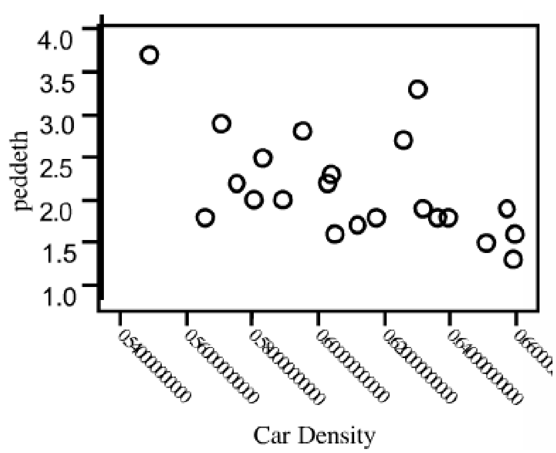

Figure 5. The Relationship Between Pedestrian Death Rates and Car Density

Figure 5 is a scatter plot representing the relationship between pedestrian death rate (dependent variable) and car density (independent variable). After examining the graph, although there seems to be linear relationship, the plots are slightly dispersed.

Since the independent variables were not normally distributed, the Spearman's rank correlation coefficient was used. Table 1 shows correlations between pedestrian death rates and the percent of people who walk to work, the pedestrian danger index, car density, and residential density. These values were calculated with a 1-tailed significance level. Table 1 shows a weak positive relationship between pedestrian death rate and the percent of people who walk to work. However, the relationship is not significant.

Table 1. Spearman's Correlation Coefficient with Pedestrian Death Rate

Independent Variables	Spearman's correlation
% Who Walk to Work	.173
Pedestrian Danger Index	.692**
Car Density	-.563**
Sprawl Index	.318*
Residential Density	.329*
Land Use Mix	-.115
Street Connectivity	.563**

* significant at <.10; ** significant at <.05

This research unexpectedly finds that a strong negative correlation exists between pedestrian death rates and car density. This relationship is significant at p=.05. Having a negative correlation between pedestrian death rates and car density means that the lower the car density (fewer cars available per worker), the higher the pedestrian fatality rate. This argues against the assumption in this research, which is that such cities would have higher rates of walking and therefore more opportunities for pedestrian deaths. Instead, cities where there are relatively few cars per worker have the highest death rates.

The results suggest that the more compact a city is (the less sprawling it is), and the greater the residential density, the higher the pedestrian death rate. Higher land use mixes are also associated with higher rates of pedestrian fatalities, but this is not significant. These findings strongly support the expectation that denser cities are more dangerous, but they are clearly not consistent with sprawl research (Ewing, 2004). Although sprawling suburban environments will be highly dependent on automobiles for work as well as shopping, school transportation, and recreation, they do not have a higher fatality rate for pedestrians. It appears instead that more compact, less automobile dominated cities actually have higher pedestrian death rates.

4. CONCLUSION

These results are based on only 19 metro areas, and it remains to be seen how applicable these findings are to all American cities. Relatively few variables were used, yet. the significance of the findings suggest that urban form is implicated in pedestrian death rates. The fact that the PDR is calculated at the level of entire metropolitan areas, while pedestrians experience individual streets and neighborhoods, calls for additional research within metropolitan areas to identify how pedestrian safety varies among neighborhoods. The identification of sprawling and urban areas within cities (Weber and Sultana. 2005) would be very useful for such an approach.

While cities before the industrial revolution relied primarily on walking and some of the denser cities still have a high percentage of walking today, the U.S. as a whole depends primarily on personal automobiles. It should be no surprise that motor vehicle safety and accidents should be a higher priority than pedestrian safety. In contrast, in developing countries (where 90% of the world's road deaths take place) pedestrians, bicyclists, and scooter drivers are the majority of traffic deaths (Martinez and Porter, 2004).

Pedestrian death rates are affected by many factors. Blame may be placed on pedestrians themselves, and as Mittmeyer (1999) suggests, the intoxication of pedestrians is an important cause of the pedestrian death rate. The design of streets is also a problem, as roadways are built for speed and do not lake pedestrians into consideration (Mittmeyer, 1999; Ernst, 2002). Urban arterial streets often lack pedestrian safety facilities, making it extremely dangerous to cross them (Mioerd, 1999). This can be traced to the lack of government funding and support for pedestrians and facilities. Transportation officials treat sidewalk maintenance as of lesser importance than other modes of transportation (Sparta, 2004).

Urban vehicle density provides a straightforward approach to explaining pedestrian deaths. Despite the construction of low density automobile dominated urban environments, it appears that high density cities remain the most dangerous places for pedestrians. The hypothesis that a relationship exists between pedestrian deaths and metropolitan statistical areas with high rates of vehicle use was not supported.

One of the goals of the New Urbanism is to create suburban developments that are more pedestrian oriented, and these developments do have extensive sidewalk and walking paths. However, most pedestrians are only willing to walk a short distance (several hundred feet). It does not appear that these will be heavily utilized for work or shopping trips unless densities are much higher, though they are popular with recreational walkers (Southworth, 1997). While they may improve safety for children and the elderly, the results of this research suggest they would have little effect on overall pedestrian fatality rates.

6. REFERENCES

Clark, B. A. J. 2002. Overview of light and crime studies. http://www.asv.org.au/odlighting/node4.html. Last accessed 14 May 2005.

Dowswell, T., and T. Elizabeth. 2002. Social deprivation and the prevention of unintentional injury in childhood: a systematic review. Health Education Research 17: 221-237.

Ernst. M. 2002. Mean Streets 2002. http://www.transact.org/report.asp?id=202. Last accessed 12 May 2005.

Ewing, R., R. Pendall. and D. Chen. 2004. Measuring Sprawl and its Impacts. http://www.smartgrowthamerica.com/. Last accessed 16 May 2005.

Fitzgibibbon, J. 2003. Portland Sets Pace. The Oregonian. CO2.

Hine. J. 1996. Pedestrian travel experiences. Journal of Transport Geography 4: 179-199.

Horvath. R. J. 1974. Machine space. Geographical Review 64: 167-188.

Kaldenbach, T. 2004. America's mean streets getting meaner in Most places. US Newswire 3.

Keegan, O., and M. O'Mahony. 2003. Modeling pedestrian behaviour. Transportation Research A 37: 889-901.

Martinez. K. L. H ., and B. E. Porter. 2004. The likelihood of become a pedestrian fatality and drivers' knowledge of pedestrian rights and responsibilities in the commonwealth of Virginia Transportation Research F 7: 43-58.

Minerd, J. 1999. Protecting pedestrians. The Futurist, 33(7). 13.

Mittmeyer, H.J. 1999. Severity of injury of alcohol intoxicated pedestrians in street traffic. http://www.ncbi.nlm.nih.gov/entrez/query.fcgi?cmd=Retrieve&db=PubMed&list_uids=1811504&dopt=Abstract. Last accessed 4 May 2005.

Saporta, M. 2004. Planners should put feet on par with car. The Atlanta Journal Constitution, 6F.

Southworth, M. 1997. Walkable suburbs? Journal of the American Planning Association 63: 28-45.

US Bureau of the Census. 2005. American Fact Finder. http://factfinder.census.gov/servlet/DTGeoSearchByListServlet?ds_name=ACS_C2SS_EST_G00_&state=dt. Last accessed 15 May 2005.

Victoria Transport Policy Institution 2005. Online Transportation Demand Encyclopedia. http://www.vtpi.org/tdm/tdml2.htm. Last accessed 16 May 2005.

Weber, J., and S. Sultana. 2005. The Impact of Urban Sprawl on Commuting Behavior. Presented at the Annual Meeting of the Association of American Geographers, Denver, Colorado, April 5-9.

Whitelegg, J. 1987. A geography of road traffic accidents. Transactions of the Institute of British Geographers 12: 161-176.