FINAL REPORT

TRAFFIC AND HIGHWAY GEOMETRIC CHARACTERISTICS ASSOCIATED WITH PEDESTRIAN CRASHES IN VIRGINIA

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Supplementary Notes

Abstract

Although motor vehicle traffic volume continues to increase, recent studies have shown that in most cities about 90 percent of all internal trips within the central business district are walking trips. Additionally, those rural areas experiencing high growth rates are also contending with increases in pedestrian traffic.

As pedestrian traffic grows, and the inevitable conflicts between pedestrians and motorists become more frequent, it is axiomatic that the level of risk, particularly for the pedestrians, increases as well. Between 1990 and 1994, pedestrian deaths accounted for 10.1 to 12.5 percent of all traffic fatalities in Virginia. This figure suggests that pedestrian safety improvement can be a promising candidate for the attention of state safety program officials, and that innovative countermeasures should be reviewed. This study was initiated to determine the traffic and geometric characteristics that significantly affect the safety of different classifications of pedestrians as a first step in the identification of potentially effective countermeasures for reducing pedestrian deaths and injuries resulting from crashes with motor vehicles.

Data for this project were obtained from police accident reports involving pedestrian crashes over a 3-year period (1988 through 1990). The data were analyzed using inferential statistics to determine the significant characteristics of pedestrian/motor vehicle crashes. The results indicate that age of the pedestrian, location of the crash, type of facility, the use of alcohol, and type of traffic control at the site have significant impact on the risk of pedestrian involvement and the likely severity of injury in motor vehicle crashes. Also, younger pedestrians are more likely to be involved in crashes than older pedestrians, and within city limits, pedestrian involvement rates are significantly higher within roadway sections that lie between the stop line at an intersection and a distance 150 ft. from the stop line.

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(The opinions, findings, and conclusions expressed in this report are those of the authors and not necessarily those of the sponsoring agencies.)

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ABSTRACT

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INTRODUCTION

As the use of motor vehicles continues to increase in the United States, drivers of motor vehicles are experiencing higher costs for parking, maintenance, and insurance, particularly in the central business districts (CBDs). As a result, more people are relying on other modes of transportation including the oldest mode of transportation, walking. In fact, "downtown origin and destination surveys in most cities show about 90% of all internal trips within the CBD are walking trips."[1] Similarly, rural areas are experiencing higher growth rates as people move away from the high cost and congestion typical of urbanized areas. Higher populations in rural areas result in higher motor vehicle and pedestrian traffic.

Approximately 10.1 to 12.5% of all fatal motor vehicle crashes in Virginia now involve pedestrian fatalities.[2] In addition, children have a higher risk of being involved in a pedestrian crash than older people. It is important to identify those traffic and highway geometric characteristics that are prevalent in crashes involving motor vehicles and different age groups of pedestrians to facilitate the development of appropriate countermeasures for these groups. Some countermeasures that may be effective in locations with high volumes of young pedestrians, such as areas adjacent to schools and playgrounds, may not be as effective at other locations.

Previous studies conducted to identify the impact of certain traffic and geometric factors on pedestrian crashes did not investigate the impacts in terms of different pedestrian age groups. These studies included one conducted by Robertson, which concluded that the addition of traffic signals and/or pedestrian signals did not result in any significant reduction in the number of pedestrian crashes. It was even suggested that some pedestrian indications should be eliminated because they are unnecessary and contribute to delay.[3] Although this may be correct when all crashes are considered, it is likely that traffic signals and/or pedestrian signals are effective in reducing the crash involvement of pedestrians in certain age groups, particularly young pedestrians. This cannot be ascertained, however, until a detailed analysis of pedestrian crashes by age group is carried out.

To obtain insights into this problem, the Virginia Transportation Research Council (VTRC) conducted this study to determine the characteristics of crashes involving pedestrians of different age groups, and how the occurrence of such crashes is influenced by different traffic and geometric conditions.

PURPOSE AND SCOPE

The scope of this project was limited to two sets of pedestrian crashes in Virginia. The first set consists of crashes outside the city limits and the second set consists of crashes within the limits of some cities. The overall objective was to identify the characteristics of pedestrian crashes in Virginia and the geometric and traffic conditions under which pedestrians of different age groups are at a higher risk of becoming involved in a crash and, if feasible, develop guidelines to reduce their crash involvement. The specific objectives were:

- To identify pedestrian crash characteristics by age group
- To identify traffic and geometric characteristics that are predominant in crashes involving pedestrians of different age groups
- To develop a list of possible design and operational modifications that may improve the safety of pedestrians.

LITERATURE REVIEW

Sources for identifying information relevant to this study included the Transportation Research Information Service (TRIS), the VTRC Library, and the University of Virginia Libraries. The information reviewed was summarized under the following sub-headings:

- Characteristics of Pedestrian Crashes
- Causal Factors of Pedestrian Crashes
- Countermeasures for Pedestrian Crashes

Characteristics of Pedestrian Crashes Outside Virginia

Several studies [4,5,6,7,8] have indicated that younger pedestrians (between the ages of 1 and 14) are disproportionately represented in pedestrian crashes. For example, it has been shown that of all pedestrians involved in motor vehicle crashes in the province of Quebec, 37% were in the 1-14 age group, although this group constituted only 17% of the population in the province.[4] On the other hand, although older pedestrians (age 65 and greater) were found to be less likely than young pedestrians to be involved in a vehicle/pedestrian crash, older pedestrians in such crashes were two to four times more likely to die.

David and Rice[4] using a database obtained from 786 police crash reports representing all child pedestrian crashes on the island of Montreal from October 1, 1980 to March 31, 1982 also showed that these crashes were clustered within the central high residential areas, often on weekday afternoons during the summer months, and that 72% of these crashes occurred in clear weather and 72% when the road surface was dry. Further analysis of the data also revealed that these crashes occurred mainly at mid-block and the victims were mainly males. It should be noted that in that study, any location outside the intersection proper was considered as midblock. They also found that the weekday crash rate was higher than that for weekends. They suggested that this might be the result of lower traffic volumes, more family activities, and higher parental supervision during weekends.

Zegeer et al[5] analyzed pedestrian crash data retrieved from two computerized data bases (North Carolina motor vehicle crash file for the period 1980-1990 and the Fatal Accident Reporting System (FARS) for the period 1980-1990) and showed that in contrast to younger pedestrians, older pedestrians have higher overall crash frequencies during the fall and winter months. It has been suggested that the reason for this is that older pedestrians tend to wear dark clothes during the winter months. Using the FARS data base, they also showed that older pedestrians had the highest percentage (75%) of fatalities occurring in the urban area compared with 57 to 69 % for the other age groups. The North Carolina data base, however, did not show older pedestrians to have higher involvement rates in urban areas when compared with other age groups. They suggested that the reason for this was because a slightly lower percentage of North Carolina's elderly population lives in the cities in comparison with that for other states. Also, in contrast to younger pedestrians, wet roads appeared to be a problem for older pedestrians, as 17.2% of their fatalities occurred on wet roads which was found to be higher than that for the 15-44 and 14-and-under age groups.

In summary, there is strong evidence that the crash characteristics of younger pedestrians are somewhat different from those of the elderly, which gives credence to the school of thought that in selecting countermeasures, consideration should be given to the predominant age group at the location where the countermeasure is to be applied.

Causal Factors of Pedestrian Crashes

Several studies[4,6,7,9,10] have been conducted to identify the causal factors associated with pedestrian crashes. A study conducted by Preston[7] suggested that speeding in residential areas is a leading cause of young pedestrian crashes with motor vehicles. The author also indicated that inner city areas are particularly dangerous for the young pedestrian. It was also suggested that the relatively high crash rates for younger pedestrians may be attributed to two factors: (1) children make greater use of street space in urban areas for play purposes and (2) children are inherently unable to deal with the complexities of the street and the traffic environment.

Causal factors associated with older pedestrian crashes with motor vehicles have included environmental factors such as wet pavement, season, location and vehicle maneuver.[6] Older pedestrians tend to be overinvolved on wet roads during the fall and winter seasons. Many of the wintertime crashes involve left-turning vehicles, which may be due to the drivers paying attention to oncoming through traffic, accelerating when an adequate gap is found and thereby striking the elderly pedestrian who may also be unable to react or move quickly.

A major causal factor associated with middle-aged pedestrian crashes is the influence of alcohol. For example, in North Carolina 36.4% of crashes involving pedestrians between the ages of 25 and 44 years involved pedestrian drinking.[6] Using the FARS data, it was shown that nationally 34.9% of fatal crashes involving pedestrians between the ages of 25 and 44 involved pedestrian drinking.

Other factors that have been found to affect pedestrian involvement in crashes include the lack of properly marked pedestrian crosswalks on arterials and the lack of sidewalks or pedestrian pathways.[10]

Countermeasures for Pedestrian Crashes

Countermeasures that have been proposed to reduce the risk of pedestrian crashes include education programs especially for the young, interventions to reduce vehicle speeds in residential areas, the use of curb or median barriers on higher volume streets in urban areas, and the diminution of one way streets in residential areas.[4] David and Rice[4] indicated that although considerable resources have been expended on educational programs for the young, these programs have not been successful in reducing the crash rates of the younger pedestrians because children have limitations which make it difficult or impossible for them to deal with the complications of the road environment. On the other hand, other studies[6,11,12] have continued to recommend education programs as an effective countermeasure for pedestrian crashes involving both younger and older pedestrians. Some studies[11,13] have suggested that education programs are ineffective in teaching the skills that pedestrians need to deal with in the road environment. They suggested that education for pedestrians should involve the integration of complex perceptual, cognitive, and motor skills through practical training, rather than the method of verbal instruction to instill rules and knowledge at a broadly conceptual level.

Some studies[6,9,14,15] have also proposed or evaluated traffic and geometric countermeasures for reducing the risk of pedestrian crashes. For example, Zegeer[6] has suggested that the installation of certain pedestrian related signs, such as "WALK ON LEFT FACING TRAFFIC," "WALK/DON'T WALK," "WATCH FOR TURNING VEHICLES," and "WALK WITH CARE" may help in reducing the risk of pedestrians being involved in a crash with a motor vehicle. There is, however, little data available on the effectiveness of these signs with respect to different pedestrian age groups. Other traffic factors that have been investigated include one-way street systems and marked and unmarked crossings. One-way streets have been found to be safer for pedestrian traffic, since they require the pedestrian to look only in one direction. It has been shown that pedestrian crashes have increased when unmarked crossings were converted to marked (zebra) crossings in England. It was also suggested that the reason for this is that zebras are only placed at locations where traffic is already at dangerous levels and pedestrian crash risks are high. However, no indication of the relative effect of these zebra crossings on the crash involvement of different age groups of pedestrians has been found.

The importance of evaluating the relative effectiveness of traffic and geometric factors on the involvement of different pedestrian age groups is illustrated in a study conducted by Stewart.[15] Stewart's study determined that the installation of guardrails at certain locations to restrict pedestrian crossings resulted in a threefold increase in casualties for young pedestrians, whereas adult casualties remained constant. It was believed that the higher risk for children was the result of their not being seen by drivers, although they could squeeze through the vertical rails and attempt to cross the road. The young pedestrians were not being seen because when vertical guardrails are closely spaced and are viewed by drivers at a shallow angle (at a distance less than 15 m), conventional guardrails appear as an opaque wall. Therefore, when guardrails are used this factor should be considered. This is another example of why the specific characteristics of different age groups should be considered before countermeasures are undertaken.

The literature indicates that although several traffic and geometric countermeasures have been proposed for reducing pedestrian involvement risk, very few studies have been conducted to determine the effectiveness of these countermeasures for different age groups. This study was conducted to identify traffic and geometric characteristics that are predominant in crashes involving different pedestrian age groups as the first step in identifying effective countermeasures for reducing the involvement of these different age groups in crashes with motor vehicles.

METHODOLOGY

Compilation of Crash Data

The first set of data was obtained from computerized files maintained by the Virginia Department of Transportation (VDOT) on crashes involving a fatality, injury, or property damage of a specified dollar amount that occurred outside of city limits (Table 1). This amount was $500 between 1988 and June 1989, $750 between July 1989 and June 1992, and is now $1,000. Relevant information for all pedestrian crashes that occurred in 1988, 1989, and 1990 was extracted from these computerized files and recorded into a new data set for analysis. Information extracted included the age of the pedestrian, location, whether an intersection was involved, the type of intersection and traffic control, type of collision, severity (property damage only, injury or fatal), speed limit on the road, the type of traffic control, and type of facility. A total of 1999 pedestrian crashes were recorded for the outside-city-limits data for the study period. The second set of data, involving pedestrian crashes within city limits, was unfortunately not stored in computerized files, which required manual extraction of the relevant data from the police accident report forms (Table 2). Since the time required to extract the data for all cities would be excessive, a random selection of seven cities was made for the study. The cities selected were Alexandria, Chesapeake, Fredericksburg, Lynchburg, Richmond, Roanoke, and Virginia Beach. The total population of these cities represents about 49% of the total population within all city limits in Virginia. In addition to the types of information extracted for the first set of data, road and street names were also extracted to help locate intersections accurately. A total of 1406 crashes were recorded for the study period inside city limits.

Age Classification

To identify crash characteristics for different age groups, the pedestrian crashes were further classified by age. The grouping was carried out so that each group had a beginning age and an ending age that coincided with corresponding ages in the population data for Virginia used in the study. The other factor taken into consideration was the availability of adequate data in each age group for meaningful analysis. After several trials, it was decided to select the following age groups: ≤ 14, 15-19, 20-29, 30-39, 40-54, 55-64, and older than 64. Table 3 shows the population in each age group. The number of crashes in each age group for the two sets of data appears in Tables 1 and 2. The crashes in each age group were further classified with respect to their location. The locations used were: (1) within an intersection (zone 1), (2) just outside the intersection, i.e. from the stop line to a distance 150 ft away from the stop line (zone 2), and (3) at midblock (zone 3). These three zones are shown in Figure 1. Note that in most previous studies, crash locations were identified as either within the intersection, or midblock. The number of crashes by location for each age group is also shown in Tables 1 and 2. All crashes that occurred within zones 1 and 2 (intersection related crashes) were further classified with respect to the type of intersection and severity level (injury and fatal). Tables A-1 through A-4 in Appendix A show the number of crashes and severity level (injury and fatal) for each

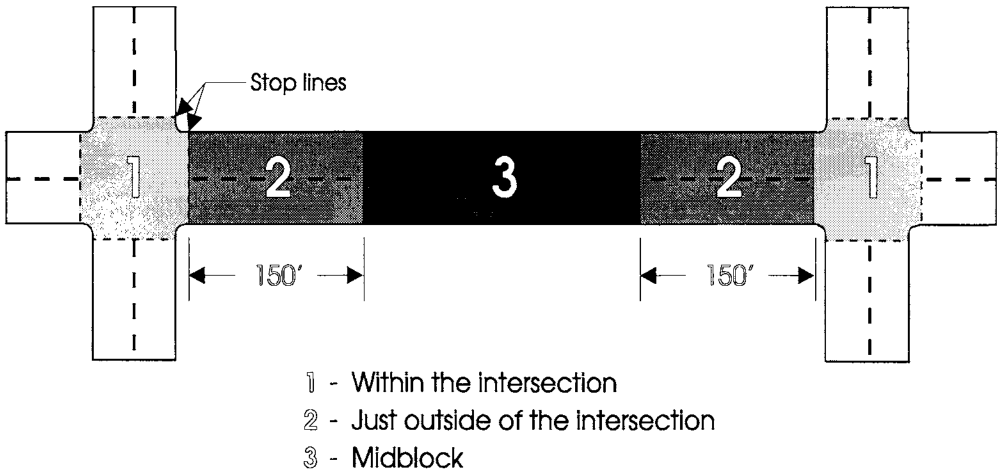


Figure 1. Accident Zones.

TABLE 1. NUMBER OF PEDESTRIAN ACCIDENTS BY AGE GROUP AND ACCIDENT LOCATION (OUTSIDE CITY LIMITS) 1988-1990

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	39	206	277	522
15-19	26	96	117	239
20-29	36	142	214	392
30-39	32	116	160	308
40-54	32	113	158	303
55-64	7	46	46	99
> 64	13	59	64	136
TOTAL	185	778	1,036	1,999

TABLE 2. NUMBER OF PEDESTRIAN ACCIDENTS BY AGE GROUP AND ACCIDENT LOCATION (WITHIN CITY LIMITS) 1988-1990

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	43	270	139	452
15-19	13	77	44	134
20-29	27	164	89	280
30-39	32	123	62	217
40-54	27	99	40	166
55-64	13	53	15	81
> 64	9	50	17	76
TOTAL	164	836	406	1,406

TABLE 3. VIRGINIA'S POPULATION BY AGE GROUP

Age Group	Outside City Limits	Within City Limits[a]
≤14	805,297	460,750
15-19	276,918	161,638
20-29	632,104	462,003
30-39	697,141	387,564
40-54	785,528	260,685
55-64	326,537	176,106
> 64	407,411	257,068
Total	3,930,936	2,165,814

[a] Cities included are Alexandria, Chesapeake, Fredericksburg, Lynchburg, Richmond, Roanoke, and Virginia Beach.

category that occurred at Cross and T-intersections separately. In addition, all crashes for each set of data were further classified by severity (injury and fatal), traffic control, type of facility, and pedestrian alcohol involvement. Tables A-5 and A-6 in Appendix A show crashes by severity level and age for within city and outside city limits respectively. Tables A-7 through A-10 show crashes at intersections by type of control while Tables A-11 through A-14 show the number of crashes by age, location, and type of facility. Tables A-15 and A-16 show the number of crashes by age group that involved pedestrians who were drunk. It should be noted that the involvement of different age groups of pedestrians in crashes may be influenced by the relative amount of travel by foot made by each age group. This factor, unfortunately cannot be considered in this study, as the relevant data for such an analysis were not available. Involvement rates were therefore based on an alternative exposure as discussed in the following section.

Risk Assessment

A desirable method for describing the risk of a pedestrian being involved in a collision with a motor vehicle while crossing a street is:

$$R = A/PV \quad (1)$$

where:

A = number of pedestrian crashes
P = pedestrian volume
V = automobile volumes.

Unfortunately, it was impossible to express these pedestrian crashes in terms of risk as described above. The volume of pedestrians at the crash locations was unknown since the databases used did not include this information. Unfortunately, this is an example of the lack of adequate relevant data needed for meaningful analysis of pedestrian crashes. In this study, risk was expressed as an involvement rate, which is defined as the ratio of the number of pedestrian crashes associated with a given traffic and/or geometric factor in a given age group to the population in that age group.

$$R_{ig} = \frac{A_{ig}}{P_g} \quad (2)$$

where:

R_{ig} = crash rate for a given traffic and/or geometric factor (i) in a given population in age group g

A_{ig} = number of crashes associated with a given traffic and/or geometric factor (i) involving pedestrians in age group g

P_g = population in age group g

This definition of risk permits the statistical comparison of the effect of different traffic and geometric factors on the crash involvement of pedestrians in the different age groups.

Tests for Significance

t-Test

The t-test was used to test several null hypotheses at a significance level of $\alpha = 0.05$. The following null hypotheses were tested:

1. The involvement rates for all pedestrian crashes outside the city limits within 150 ft of the stop line (zone 2) and those within the intersection (zone 1) are the same.

2. The involvement rates for all pedestrian crashes outside the city limits at midblock (zone 3) and within 150 ft from the intersection (zone 2) are the same.

3. The involvement rates for all pedestrian crashes are the same for roads outside the city limits and roads within the city limits.

4. The involvement rates for all pedestrian crashes at midblock (zone 3) are the same for roads outside the city and roads within the city.

5. The involvement rates for fatal crashes outside the city limits within 150 ft of the stop line (zone 2) and those within the intersection (zone 1) are the same.

6. The involvement rates for fatal crashes within 150 ft of the stop line (zone 2) are the same for roads outside and inside the city limits.

7. The involvement rates for fatal crashes at midblock (zone 3) are the same for roads outside and inside the city limits.

8. The involvement rates for fatal crashes outside the city limits are the same for zones 2 and 3.

9. The involvement rates for fatal crashes on roads within the city limits in zones 1 and 2 are the same.

10. The involvement rates for fatal crashes within the city limits are the same for zones 2 and 3.

11. The crash involvement rates of pedestrians at intersections controlled with traffic signals are the same as for those for intersections controlled with stop signs.

12. The crash involvement rates of pedestrians at cross and T-intersections are the same.

Proportionality Test

In order to test whether a significant difference existed between the proportions of crashes outside the city limits that are fatal in zones 2 and 3, the proportionality test of significance was used.

The proportionality test is a test of the equality of two independent means, namely p_1 and p_2, which are the probabilities of success resulting from two different processes. The test statistic is the Z value, which is given as:

$$Z = \frac{(p_1 - p_2)}{\sqrt{p(1-p)[(\frac{1}{n_1})+(\frac{1}{n_2})]}} \qquad (3)$$

where p_1 and p_2 are the two proportions to be compared, p is the pooled estimate, and n_1 and n_2 are the population sample sizes:

$$p_1 = \frac{Y_1}{n_1} \qquad (4)$$

$$p_2 = \frac{Y_2}{n_2} \qquad (5)$$

$$p = \frac{(Y_1 + Y_2)}{(n_1 + n_2)} \qquad (6)$$

where Y_1 and Y_2 are the number of successes for populations 1 and 2 . This test was used to test the null hypothesis H_0: $p_1 = p_2$ against that of H_1: $p_1 > p_2$. If the calculated Z-statistic is greater than Z_α, which is the Z statistic corresponding to a significance level of α, than the null hypothesis is rejected and H_1 is accepted.

In this study, a 95% confidence level was selected, corresponding to a $Z_\alpha = 1.645$.

RESULTS AND DISCUSSION

Characteristics of Pedestrian Accidents

The general characteristics of pedestrian accidents are given in terms of age, location, severity, and the influence of alcohol on the pedestrian.

Age and Location

Figure 2 shows the involvement rates of pedestrians by age group for the two sets of data (within the city limits and outside the city limits). Within city limits, the figure clearly indicates that, in general, the risk of pedestrian crashes decreases with increase in age, except that the 40 - 54 yr. age group has a slightly higher rate than the 30-39 yr. age group. In general, younger pedestrians (14 years and younger) are more likely to be involved in pedestrian/vehicle crashes than the older people. This further suggests that emphasis should be placed in developing countermeasures for reducing the probability of young pedestrians being involved in pedestrian /vehicle crashes. Special efforts should be made to implement suitable countermeasures at locations where there are high numbers of young pedestrians, such as areas adjacent to schools and playgrounds. Emphasis should be placed on educating the young on the proper procedures for crossing highways and streets. It may be that the same level of effort being put into educating young drivers should also be put into educating young pedestrians, starting at a much younger age. Also, it is necessary that education programs involve not only verbal training to instill rules, but also the development of perceptual, cognitive and motor skills through practical training.

A similar trend is shown for pedestrians outside the city limits, except that in this case the less-than-14-yr. age group has a lower rate than the 15-19 yr. old cohort and the greater-than-64-yr. age group has a slightly larger rate than the 55-64 yr. age group.

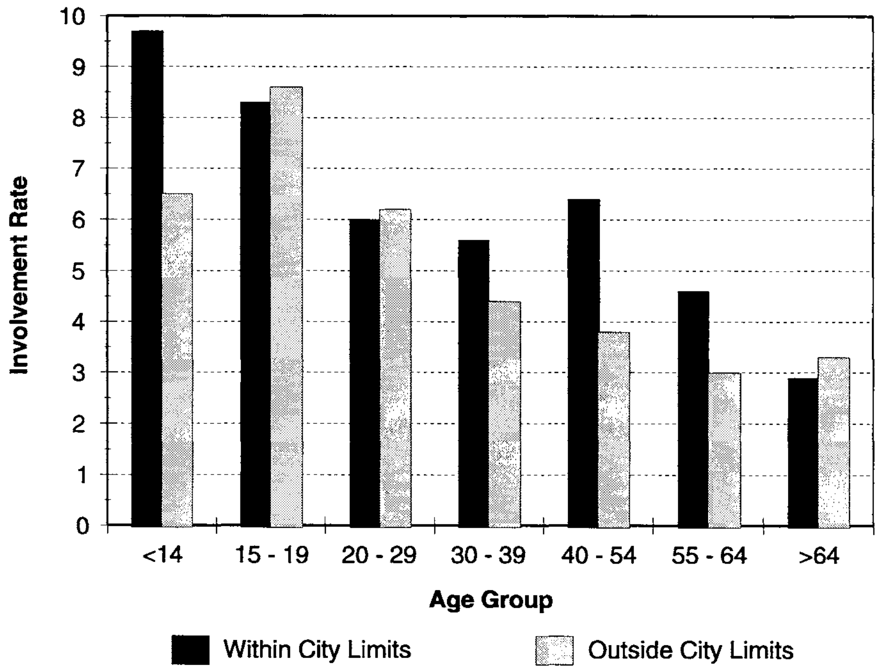


Figure 2. Involvement rate of pedestrians by age group.

Figures 3 and 4 show the involvement rates by age and location within the city limits and outside the city limits respectively. Within the city limits, the zone just outside the intersection (stop line to 150 ft from stop line, zone 2) is the most dangerous location for pedestrians in all age groups. Most studies include this zone as either part of the intersection or part of the midblock. This unfortunately deemphasizes its importance in pedestrian crashes particularly within city limits. Outside the city limits the midblock (zone 3) is slightly more dangerous than just outside the intersection (zone 2) for pedestrians in all age groups, except for the 55-64 yr age group. The rates for the two locations for the 54-64 yr age group are approximately the same. For both sets of data and for all age groups, within the intersection (zone 1) is the location

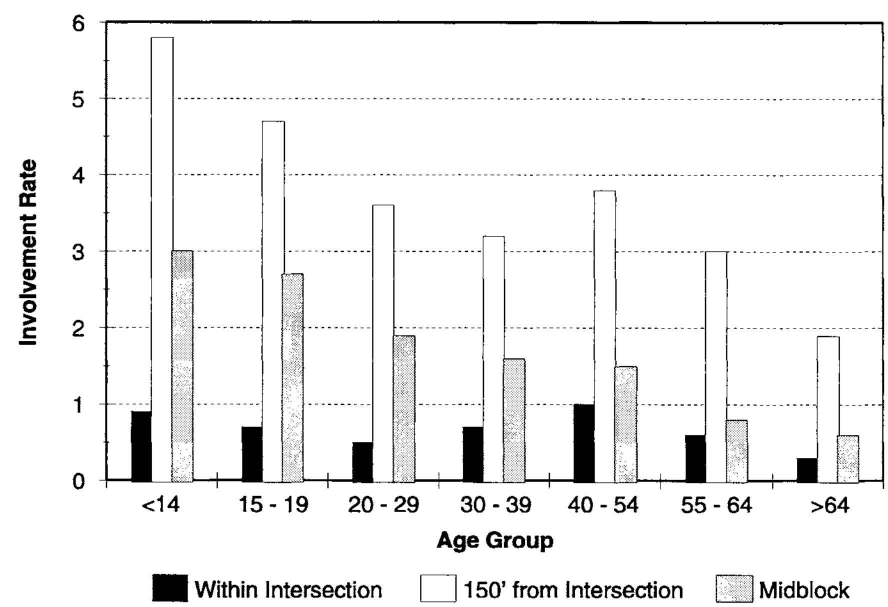


Figure 3. Involvement rate of pedestrians by age & location, within city limits.

with the least involvement rate. The phenomenon of high involvement rates just outside the intersection within the city limits may be attributed to one or both of the following reasons. Firstly, pedestrians may tend to cross highways just outside the intersection (zone 2) rather than within the intersection (zone 1); and secondly, the probability of a pedestrian being hit by an automobile is highest in zone 2, because drivers tend to concentrate their attention more on traffic movement within the intersection than on zone 2. Restricting pedestrians from crossing the highway within zone 2 will diminish the effect of these two factors on pedestrian crashes. An effective way of achieving this may be to provide physical barriers, such as guard rails, that will channel all pedestrian traffic to zone 1 of the intersection, where the provision of a suitable traffic control will allow the pedestrian traffic to cross the road in relative safety as shown in Figures 5 and 6. However, when guardrails are used, they should be constructed so that it is impossible for younger pedestrians to squeeze through the vertical bars, as this may defeat the objective of the guardrails and may even increase the crash involvement of younger pedestrians. Also, to avoid the problem of lack of visibility by drivers through the vertical rails, serious consideration should be given to the use of guardrails like the VISIRAIL, which do not appear as an opaque solid wall to drivers. This type of rail is now being used in the United Kingdom. The phenomenon of high involvement rates at the midblock zone outside the city limits is probably due to the relatively higher speeds in rural areas than in urban areas.

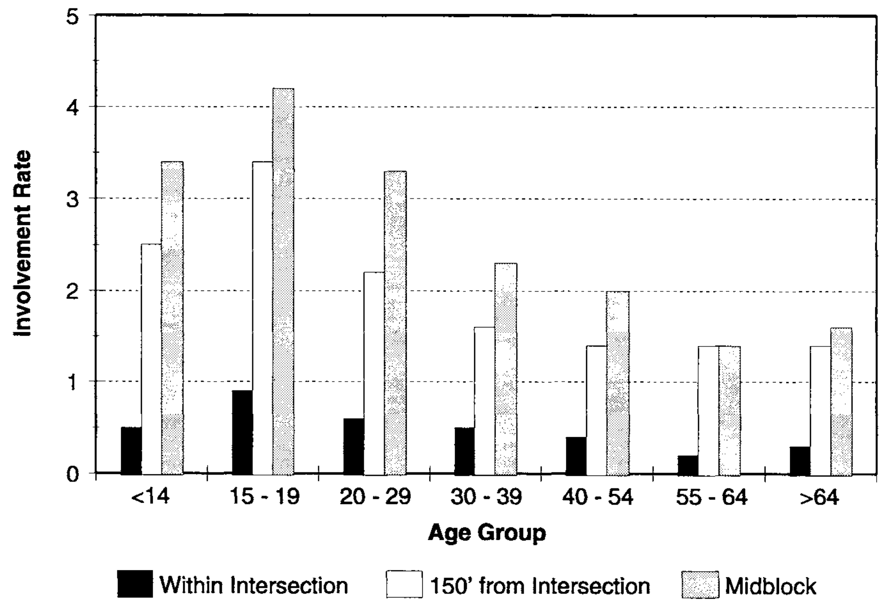
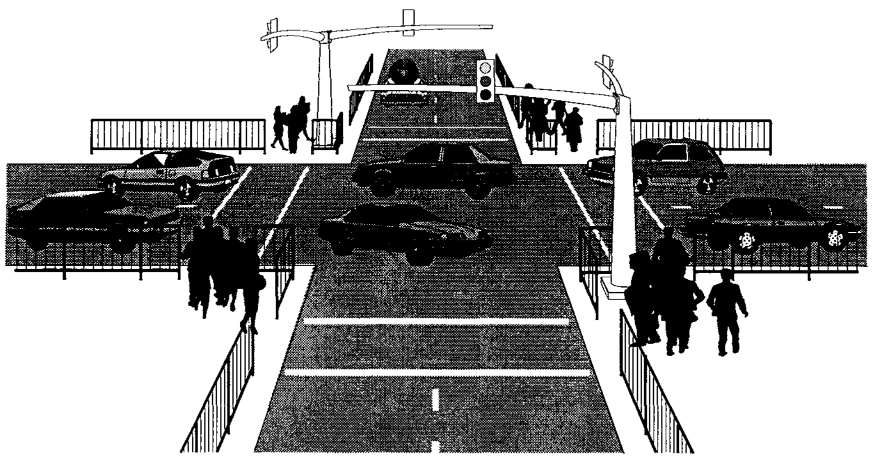


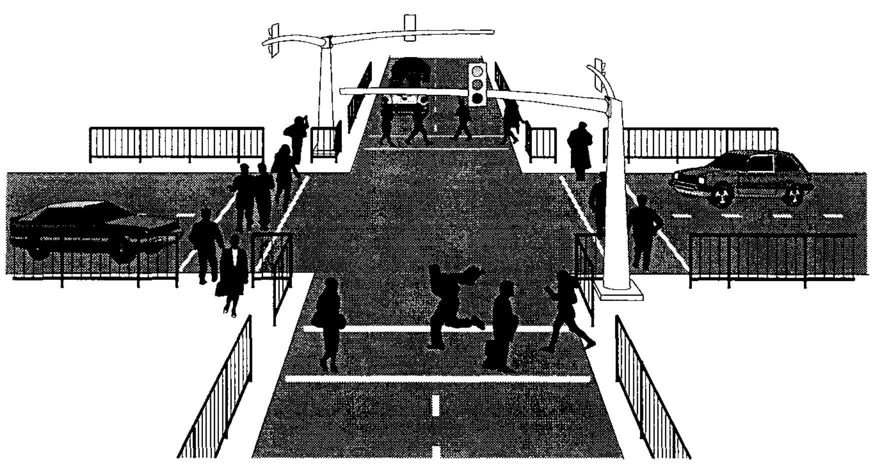
Figure 4. Involvement rate of pedestrians by age & location, outside city limits.

Severity

The injury and fatal involvement rates are given in Figures 7 and 8 for areas outside the cities and within the cities. The fatal involvement rates for residents outside the cities are generally higher than those for residents within the cities. This may be associated with the relatively higher speeds of vehicles on roads outside the cities compared with the speeds of vehicles within the cities. In the areas outside the cities the older pedestrians (older than 64 yrs) exhibit the highest fatal crash involvement rates. This high fatal involvement rate of the older pedestrians is, however, not due to their overall involvement, as they have the lowest overall involvement rate. The older pedestrians' frailty increases the probability that a crash involving an older pedestrian will result in a fatality. The fatal involvement rate for pedestrians within the cities exhibit a different distribution than those for pedestrians outside the cities. In this case, the ≤ 14 yr. age group has the highest fatal involvement rate. The relatively high fatality rate of the ≤ 14 yr. age group is associated with the high overall rate of this age group. However, the relatively higher fatality crash rate of the 40-54 yr. age group may be associated with the relatively higher proportion of drunken pedestrians in this age group involved in crashes, as will be shown in the next section.



A. Traffic crossing intersection while pedestrians wait.



B. Pedestrians crossing intersection during all red phase.

Figure 5. Pedestrian guardrails and actuated pedestrian signals at an intersection.

A. Children activating a signal at midblock.

B. Children crossing at midblock after traffic is stopped.

Figure 6. Guardrails and pedestrian activated signals at midblock.

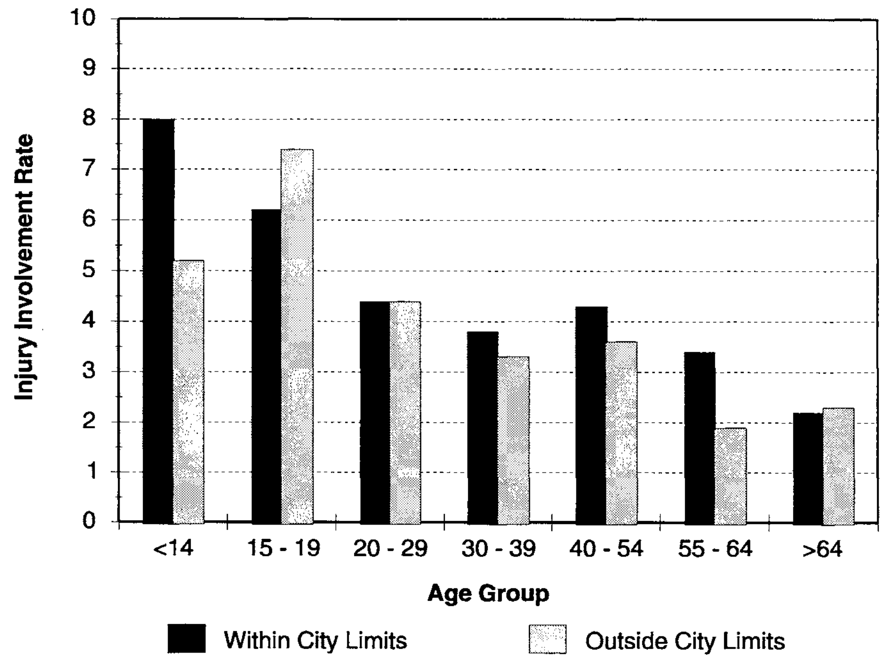


Figure 7. Injury involvement rates by age group.

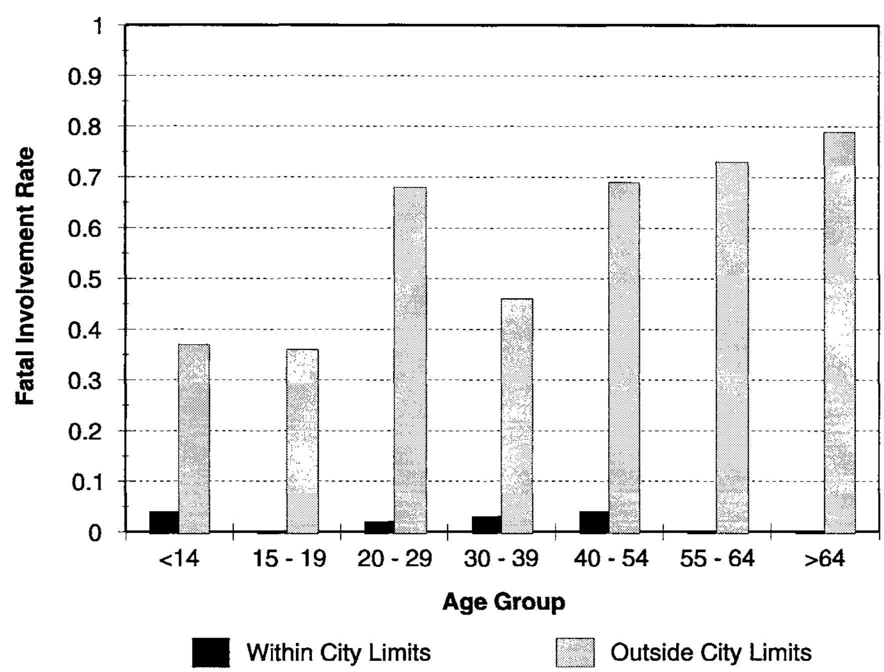


Figure 8. Fatal involvement rates by age group.

Alcohol Involvement

Figure 9 shows the percentage of pedestrian crashes in each age group for which the pedestrians involved in the crashes were obviously drunk. It shows that the 30-39 yr. age group outside city limits and the 40-45 yr. age group within city limits have the highest proportion of crashes involving drunken pedestrians. The relatively high fatal crash rate of the 40-45 age group within the city limits shown in Figure 8 may be associated with this.

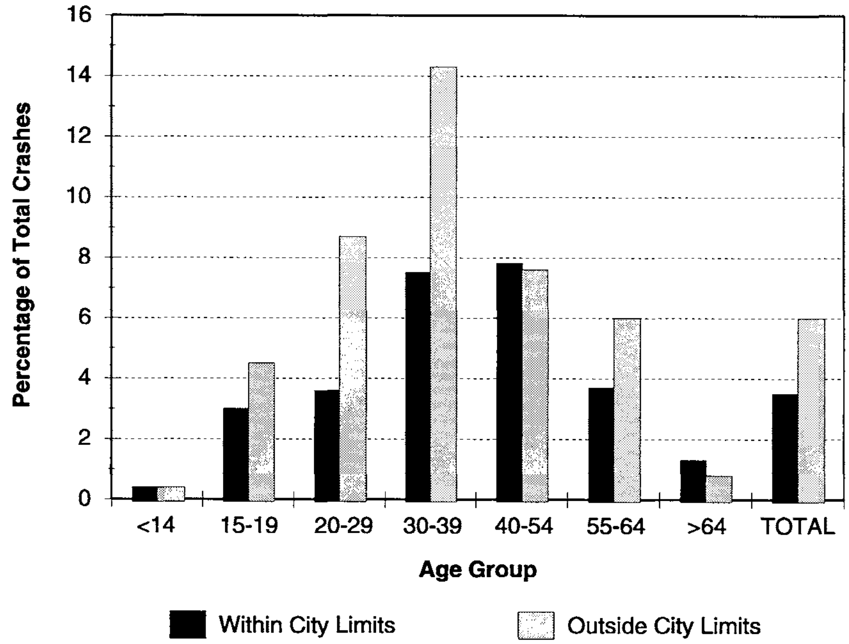


Figure 9. Percentage of crashes involving drunken pedestrians by age group.

Traffic Control

Figure 10 shows the average involvement rates by age groups at intersection within the city limits with no traffic control, stop signs, and traffic signals. This figure shows that the youngest age group (≤ 14) has the highest risk of involvement in pedestrian/vehicle crashes at intersections with no traffic control. Also, the involvement rates at signalized intersections tend to be

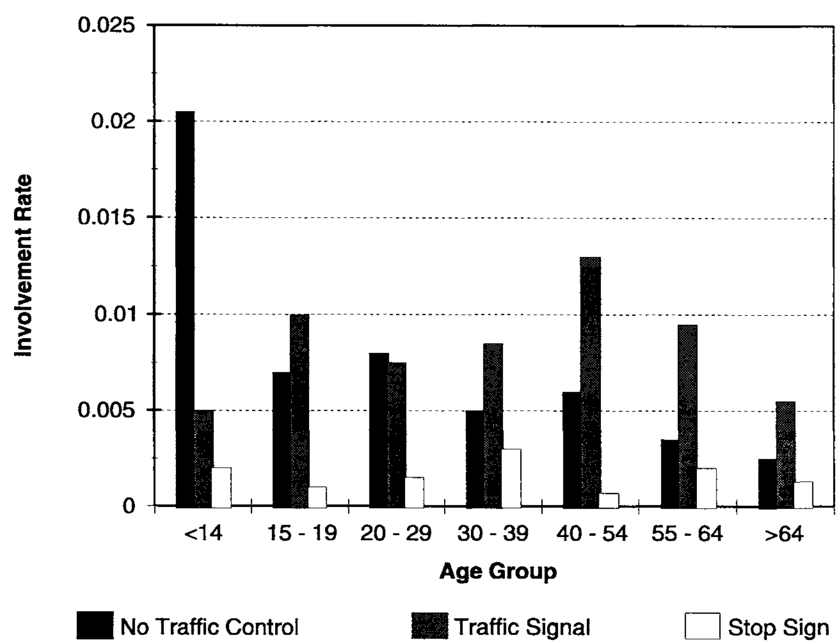


Figure 10. Pedestrian involvement rate, traffic control within city limits.

relatively higher than those at stop signs. This disparity between the involvement rates at intersections with stop signs and those with traffic signals might be attributed to the manner in which traffic flows across the intersection under different control systems. At intersections controlled by stop signs (particularly all-way stop signs), oncoming vehicles must always come to a stop, thereby providing an opportunity for pedestrians to cross through the intersection. At an intersection controlled by a traffic signal, however, this opportunity is not provided unless there is an all-red phase. For example, right-turning vehicles are usually in conflict with pedestrians crossing the intersection, thus creating a greater danger to pedestrians. It is essential that at signalized intersections with high pedestrian volumes, adequate provisions be made to allow pedestrians to safely cross. The provision of the minimum green phase in the direction of the pedestrian flows may not be adequate because of the conflict with right-turning vehicles. Also, the high involvement rate of the youngest age group (≤14 yrs old) at intersections with no control suggests that a significant percent of these crashes occur in residential areas where intersections with no traffic control are more likely to exist.

Intersection Type

Figure 11 shows the average involvement rates at cross and t-intersections for crashes that occurred in zones 1 and 2 within city limits. For cross intersections, involvement rates within 150 feet from the intersection (zone 2) are at least triple those rates within the intersection. For t-intersections, with the exception of the 30-39 year age group, involvement rates within 150 feet of the intersection are at least double those within the intersection. While no apparent trend exists with age within the intersection, involvement rates are generally negatively correlated with age within 150 feet from the intersection (zone 2), except for the 40-54 yr. age group at cross intersections and the 40-54 and 55-64 yr. age groups at t-intersections. For both intersection categories, the under-14-yr. age group exhibits the highest involvement rate within 150 feet from the intersection. Within the intersection, the 40-54 yr. age group has the highest involvement rates at cross intersections, while the 14-yr.-and-younger age group has the highest involvement rate for t-intersections. The figure also shows that in general, involvement rates are

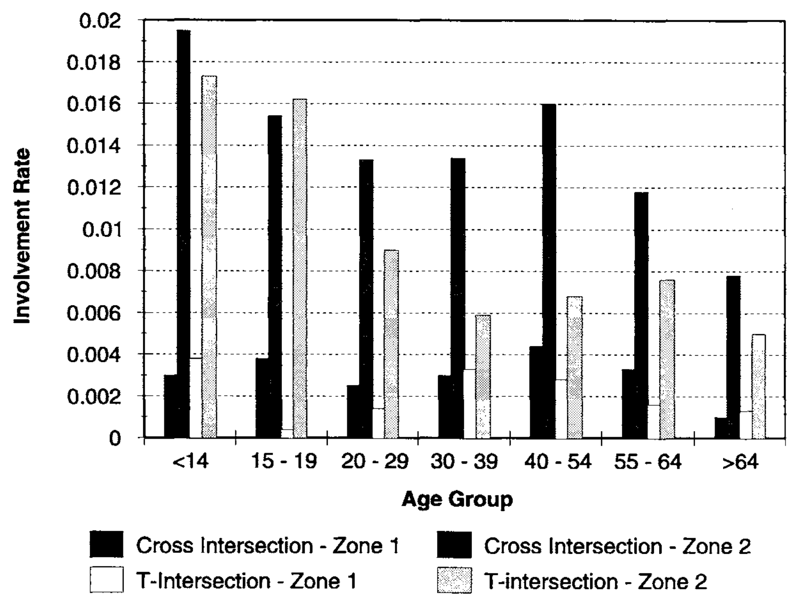


Figure 11. Pedestrian involvement rate, intersection type, within city limits.

higher at cross intersections than at t-intersections. These results suggest that special attention should be given to pedestrians at cross intersections, particularly within zone 2.

Tests of Significance

t-Test

Table 4 shows the results of the t-tests for the null hypotheses tested. The results indicate that the crash involvement rates for pedestrians in areas outside the cities are significantly higher in the zone just outside the intersection (zone 2), i.e. within 150 ft from the stop line, than for the zone within the intersection (zone 1). Null hypothesis 1 is therefore rejected. However, the involvement rate for all pedestrians outside the cities at zone 3 is not significantly higher than that at zone 2. Null hypothesis 2 cannot, therefore be rejected. Also, although the average involvement rate of pedestrians within the cities is higher than for outside the city limits, this difference is not significant. Null hypothesis 3 cannot therefore be rejected. Similarly null hypothesis 4 cannot be rejected.

For roads outside the cities, the fatal involvement rates just outside the intersection (zone 2) are significantly higher than those within the intersection (zone 1). Null hypothesis 5 is therefore rejected. The involvement rates for fatal crashes within 150 ft of the stop line (zone 2) outside the city limits are significantly higher than at the same locations for roads within city limits. Null hypothesis 6 is therefore rejected. The fatal involvement rates of pedestrians at midblock (zone 3) are significantly higher on roads outside the cities than those for similar locations on roads within the cities. Null hypothesis 7 is therefore rejected. The results also indicate that fatal crash involvement for all pedestrians outside the cities at midblocks (zone 3) is significantly higher than for pedestrians in zone 2. Null hypothesis 8 is therefore rejected.

The involvement rates of pedestrians in fatal crashes in zone 2 within the cities are not significantly higher than those for zones 1 and 3. Null hypotheses 9 and 10 cannot therefore be rejected. The results also indicate that pedestrian crash rates at signalized intersections are significantly higher than at intersections controlled with stop signs. Null hypothesis 11 is therefore rejected. However, although the involvement rates of pedestrians at cross intersections are higher than at t-intersections, this difference is not significant. Null hypothesis 12 cannot therefore be rejected.

These results suggest particular attention should be given to the provision of adequate protection to pedestrians in the area just outside the intersection (zone 2) and at midblock for roads within and outside the cities. The reason is that within the cities, although zone 2 has the highest risk for pedestrians, the risk for fatal crashes is not significantly different from that at midblock (zone 3), while for pedestrians outside the city limits, zone 3 has the highest risk for fatal crashes, although the risk for all types of crashes is similar to that for zone 2.

TABLE 4. CRASH INVOLVEMENT *t* TEST RESULTS

ASSUME THE FIRST CASE IS u_1
NULL HYPOTHESIS, H_0: $u_1 = u_2$ ALTERNATE HYPOTHESIS, H_1: $u_1 > u_2$

Comparison	Calculated *t*	Critical *t* at $\alpha = .05$
1. Involvement rates for all pedestrian crashes outside the city limits within 150 ft of the stop line (zone 2) and those within the intersection (zone 1) are the same.	**5.068721***	**2.179**
2. The involvement rates for all pedestrian crashes outside the city limits ai midblocks (zone 3) and within 150 ft of the intersection (zone 2) are the same.	**1.174416**	**2.179**
3. The involvement rates for all pedestrian crashes are the same for roads outside the city limits and roads within the city limits.	**-0.956867**	**2.179**
4. The involvement rates for all pedestrian crashes at midblocks (zone 3) are the same for roads outside the city and roads within the city.	**1.643167**	**2.179**
5. The involvement rates for fatal crashes outside the city limits within 150 ft of the stop line (zone 2) and those within the intersection (zone 1) are the same.	**4.237223***	**2.179**
6. The involvement rates for fatal crashes within 150 ft of the stop line (zone 2) are the same for roads outside and inside the city limits.	**5.658014***	**2.179**
7. The involvement rates for fatal crashes at midblocks (zone 3) are the same for roads outside and inside the city limits.	**9.677898***	**2.179**
8. The involvement rate for fatal crashes outside the city limits are the same for zones 2 and 3	**-4.521930***	**2.179**
9. The involvement rates for fatal crashes on roads within the city limits in zones 1 and 2 are the same	**-1.00000**	**2.179**
10. The involvement rates for fatal cars within the city limits are the same for zones 2 and 3.	**-1.511486**	**2.179**
11. The crash involvement rates of pedestrians at intersections controlled with traffic signals are the same as those at intersections controlled with stop signs	**6.331095***	**2.179**
12. The crash involvement rates of pedestrians at cross and T- intersections are the same	**2.004854**	**2.179**

*Indicates significant difference at a = 0.05

Proportionality Test

Results obtained from the proportionality tests are indicated in Table A-6. The results indicate that the proportion of midblock (zone 3) crashes that are fatal is significantly higher than the corresponding proportion for crashes just outside the intersection (zone 2).

SUMMARY OF RESULTS

- Young pedestrians (14 years and younger) are more likely to be involved in crashes than older pedestrians.
- In general, the risk of a pedestrian being involved in a crash decreases with increases in age.
- Within city limits, pedestrian involvement rates within a section that lies between the stop line at an intersection and a distance 150 ft from the stop line (zone 2) are significantly higher than at any other section of the road.
- Outside city limits, pedestrian crash involvement rates are higher at midblocks (zone 3) than at zone 2 but the difference is not significant.
- Fatal involvement rates in zone 2 are significantly higher for pedestrians outside the cities than for those within the cities.
- Crash involvement rates for pedestrians 14 yrs. of age and younger within the city limits are higher at intersections with no traffic control than at signalized ones.
- For all pedestrians, crash involvement rates tend to be significantly higher at signalized intersections than at intersections controlled by stop signs.
- Pedestrian involvement rates are higher at cross-intersections than at t-intersections, but this difference is not significant.
- Alcohol plays a major factor in pedestrian crashes, especially with the middle age group (30-54 yrs. old).

CONCLUSIONS

1. The high involvement rates of young pedestrians at intersections with no control suggest that most of the crashes occur in residential areas where intersections of this type are most likely

to exist. To reduce this high rate of young pedestrians in crashes, special effort should be made to implement countermeasures for pedestrian/vehicle crashes in residential areas.

2. Within city limits, the zone just outside the intersection (stop line to 150 ft. from stop line, zone 2) is the most dangerous location for pedestrians. In order to reduce the risk of pedestrians at this zone, pedestrians should be restricted from crossing the road within this zone.

3. On roads outside city limits, although pedestrian involvement rates tend to be higher at midblocks areas (zone 3) than at other sections of the road, the difference between the involvement rates in zones 2 and 3 is not significant. However, fatal crashes are significantly higher at midblocks (zone 3) than at the section from the stop line to 150 ft. from the stop line (zone 2). This is probably due to the relatively high speeds of vehicles outside the city limits. Specific countermeasures should therefore be implemented at these locations, to ensure that pedestrians cross at these locations with little or no interaction with moving vehicles.

4. Since cross signalized intersections are particularly dangerous for pedestrians, countermeasures should be implemented at these locations to ensure that pedestrians cross these intersections with minimum interaction with turning vehicles. This requires that capacity of the intersection should not be the primary objective in designing the signalized system. Every effort should be made to provide adequate time for pedestrians to cross the intersection without any interference from moving vehicles.

5. The involvement of alcohol in middle-aged pedestrian crashes (30-54 yrs. old) is a problem of significance in Virginia, particularly in areas outside the city limits.

POTENTIAL TRAFFIC ENGINEERING COUNTERMEASURES FOR PEDESTRIAN CRASHES

This study did not undertake the evaluation of specific countermeasures, nor has the literature survey identified results on the effectiveness of specific countermeasures for different age groups. The study, however, has identified the significant crash characteristics of different age groups of pedestrians, and through the literature survey has also identified several countermeasures that have been used for pedestrian crashes either in the United States or abroad. The combination of the two sets of information (crash characteristics of pedestrians, and examples of countermeasures used in the United States and abroad) has been used here to identify potential countermeasures that may improve pedestrian safety. The countermeasures given in this section have *not* been proved to be effective for the conditions under which they have been listed. They are provided as potential alternatives for consideration and evaluation.

Pilot studies must be carried out to evaluate the effectiveness of each of these countermeasures for the conditions under which they will operate before they are widely used.

Potential Countermeasures at Urban Residential Areas

These countermeasures may contribute to the reduction of the high involvement rates of the young pedestrians ($\leq$ 14 yr.) in crashes. Potential countermeasures for these locations can be grouped into three general categories: (1) those which influence drivers to reduce speeds (traffic calming), such as traffic humps, lane width reduction and traffic circles, (2) those which completely separate vehicular traffic from pedestrian traffic, and (3) education. The separation of vehicular traffic from pedestrian traffic usually involves physical construction that may be expensive, and may be opposed by residents because they may have to park their vehicles some distance away from their homes. Of the three general categories (traffic calming, separation of vehicular and pedestrian traffic, and education) traffic calming and education seem to be the easiest to implement with little or no opposition by residents. The following are therefore suggested as potential countermeasures for urban residential areas:

- Installing traffic humps at regular intervals to encourage drivers to reduce speeds. A pilot study should be carried out to identify the most effective spacing, shape and size for the humps. The objective here is to force drivers to reduce their speeds to the appropriate selected speed for the residential area, without creating a hazardous situation for the vehicle.

- Provide lane markings that reduce the width of the travel lanes. This method has been used in Europe.

- Provide traffic circles at unsignalized intersections. The radii of these traffic circles should be small enough to force drivers to reduce speed at the unsignalized intersections, without creating a dangerous situation for the driver.

- Provide adequate advance warning signs informing drivers of the existence of all traffic calming features.

- Develop an aggressive education program for the young as part of the curriculum in kindergarten through second grade. Such a program must include the teaching of skills that pedestrians need to deal with the road environment. For example the program should include lessons on the integration of the perceptual, cognitive and motor skills through practical training.

Potential Countermeasures in Urban Non-Residential Areas

The most dangerous location for pedestrians in these areas is just outside the intersection (stop line to 150 ft from stop line (zone 2) of signalized intersections. The objective here is to restrict pedestrians from crossing the road at this location, while providing a safe environment for the pedestrian to cross the road within the intersection. The following is suggested as a potential countermeasure:

- Install suitable guardrails such as the VISIRAIL along the edge of each walkway up to a distance of 150 ft from the stop line to channel all pedestrian traffic to zone 1 of the intersection. In addition, install a pedestrian activated signal system that will provide an adequate ALL-RED phase for pedestrians crossing within the intersection.

Potential Countermeasures in Areas Outside Cities

In these areas pedestrian crashes are higher at midblocks, although not significantly so. Suitable countermeasures should be provided both at midblock and just outside the intersection. The following are suggested as potential countermeasures:

- At midblock locations with high pedestrian crash rates, install suitable guardrails such as visirail to channel all pedestrians crossing the road to a specific location as shown in Figure 6. In addition, provide a signalized system with a pedestrian activated ALL-RED phase that will stop all vehicles going through while pedestrians have the right of way. Adequate warning signs must also be provided to inform drivers of the midblock signals.

- At the intersections, provide the same countermeasure as for areas within the cities.

RECOMMENDATIONS

It has been shown that zones 2 and 3 are the most dangerous locations for pedestrians, and very little information is available on the effectiveness of the different countermeasures available. It is therefore recommended that the Traffic Engineering Division of VDOT and the district traffic engineers be consulted in order to obtain their input in selecting from the potential countermeasures listed in this report those that are of most probable benefit to the Commonwealth of Virginia. Pilot projects should be conducted to evaluate the effectiveness of these selected countermeasures in reducing the crash rates of different ages of pedestrians at both intersections and midblocks. The selection of study sites must also be made with the full participation of the district traffic engineers.

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APPENDIX

TABLE A-1

Number of Pedestrian Accidents by Age Group and by Severity Level
(Within City Limits)
1988 -1990
Cross Intersections*

AGE GROUP	ACCIDENT LOCATION						TOTAL	
	WITHIN INTERSECTION		WITHIN 150 FT FROM STOP LINE		MID-BLOCK			
	Injury	Fatal	Injury	Fatal	Injury	Fatal	Injury	Fatal
≤ 14	20	0	122	0	--	--	142	0
15-19	8	0	30	0	--	--	38	0
20-29	12	0	74	0	--	--	86	0
30-39	7	0	63	0	--	--	70	0
40-54	15	0	45	0	--	--	60	0
55-64	7	0	26	0	--	--	33	0
> 64	4	0	25	0	--	--	29	0
TOTAL	73	0	385	0	--	--	458	0

* Total Number of Cross Intersections = 142

TABLE A-2

Number of Pedestrian Accidents by Age Group and by Severity Level
(Within City Limits)
1988-1990
T-Intersections*

AGE GROUP	ACCIDENT LOCATION						TOTAL	
	WITHIN INTERSECTION		WITHIN 150 FT FROM STOP LINE		MID-BLOCK			
	Injury	Fatal	Injury	Fatal	Injury	Fatal	Injury	Fatal
≤ 14	18	0	74	0	--	--	92	0
15-19	1	0	25	0	--	--	26	0
20-29	6	0	37	0	--	--	43	0
30-39	10	0	20	0	--	--	30	0
40-54	6	0	16	0	--	--	22	0
55-64	3	0	12	0	--	--	15	0
> 64	3	0	11	0	--	--	14	0
TOTAL	47	0	195	0	--	--	242	0

* Total Number of T-Intersections = 92

TABLE A-3

Number of Pedestrian Accidents by Age Group and by Severity Level
(Outside City Limits)
1988-1990
Cross-Intersections*

AGE GROUP	ACCIDENT LOCATION						TOTAL	
	WITHIN INTERSECTION		WITHIN 150 FT FROM STOP LINE		MID-BLOCK			
	Injury	Fatal	Injury	Fatal	Injury	Fatal	Injury	Fatal
≤ 14	9	0	63	0	--	--	72	0
15-19	7	0	37	0	--	--	44	0
20-29	10	1	42	5	--	--	52	6
30-39	8	1	27	2	--	--	35	3
40-54	6	1	30	7	--	--	36	8
55-64	2	0	14	1	--	--	16	1
> 64	5	1	20	6	--	--	25	7
TOTAL	47	4	233	21	--	--	280	25

* Total Number of Cross-Intersections = 63

TABLE A-4

Number of Pedestrian Accidents by Age Group and by Severity Level
(Outside City Limits)
1988-1990
T-Intersections*

AGE GROUP	ACCIDENT LOCATION						TOTAL	
	WITHIN INTERSECTION		WITHIN 150 FT FROM STOP LINE		MID-BLOCK			
	Injury	Fatal	Injury	Fatal	Injury	Fatal	Injury	Fatal
≤ 14	20	1	102	4	--	--	122	5
15-19	9	1	42	2	--	--	51	3
20-29	16	1	55	6	--	--	71	7
30-39	15	0	44	4	--	--	59	4
40-54	15	2	37	6	--	--	52	8
55-64	1	2	16	6	--	--	17	8
> 64	3	0	21	5	--	--	24	5
TOTAL	79	7	317	33	--	--	396	40

* Total Number of T-Intersections = 102

TABLE A-5

Number of Pedestrian Accidents by Age Group and by Severity Level
(Within City Limits)
1988-1990
All Crashes

AGE GROUP	ACCIDENT LOCATION						TOTAL	
	WITHIN INTERSECTION		WITHIN 150 FT FROM STOP LINE		MID-BLOCK			
	Injury	Fatal	Injury	Fatal	Injury	Fatal	Injury	Fatal
≤ 14	39	0	220	0	110	2	369	2
15-19	10	0	58	0	33	0	101	0
20-29	18	0	125	1	62	0	205	1
30-39	17	0	91	0	42	1	150	1
40-54	21	0	66	0	27	1	114	1
55-64	11	0	41	0	8	0	60	0
> 64	7	0	38	0	12	0	57	0
TOTAL	123	0	639	1	294	4	1056	5

TABLE A-6

Number of Pedestrian Accidents by Age Group and by Severity Level
(Outside City Limits)
1988-1990
All Crashes

AGE GROUP	ACCIDENT LOCATION						TOTAL	
	WITHIN INTERSECTION		WITHIN 150 FT FROM STOP LINE		MID-BLOCK			
	Injury	Fatal	Injury	Fatal	Injury	Fatal	Injury	Fatal
≤ 14	36	2	196	5 (0.024)	186	23 (.083)	418	30
15-19	19	1	88	3 (0.031)	97	6 (.051)	204	10
20-29	28	2	111	13 (0.092)	142	28 (.131)	281	43
30-39	27	2	94	7 (0.060)	110	24 (.150)	231	33
40-54	24	5	85	16 (0.142)	94	33 (.210)	203	54
55-64	5	2	37	7 (0.152)	21	15 (.333)	63	24
> 64	9	2	45	11 (0.186)	40	19 (.300)	94	32
TOTAL	148	16	656	62 (0.086)	690	148 (.177)	1494	226

( ) proportion of crashes that are fatal
Using the proportionality test to test for significance
Null Hypothesis:= The proportion of accidents outside the city limits, that are fatal is the same for zones 2 and 3.

$P_1 = 0.098$ $P_2 = 0.179$
$Z = 3.57$ (significant at $\alpha = 0.05$)

TABLE A-7

Number of Pedestrian Accidents by Age Group and by Traffic Control
(Within City Limits)
1988-1990
All Intersections with Traffic Signal*

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	15	112	--	127
15-19	1	15	--	16
20-29	5	43	--	48
30-39	4	16	--	20
40-54	2	15	--	17
55-64	1	7	--	8
> 64	0	8	--	8
TOTAL	28	216	--	244

* Total Number of Intersections = 127

TABLE A-8

Number of Pedestrian Accidents by Age Group and by Traffic Control
(Outside City Limits)
1988-1990
All Intersections with Traffic Signal*

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	4	19	--	23
15-19	8	20	--	28
20-29	0	24	--	24
30-39	9	22	--	31
40-54	9	17	--	26
55-64	2	7	--	9
> 64	3	7	--	10
TOTAL	35	116	--	151

* Total Number of Intersections = 31

TABLE A-9

Number of Pedestrian Accidents by Age Group and by Traffic Control
(Outside City Limits)
1988-1990
All Intersections Controlled by Stop Signs

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	4	8	--	12
15-19	4	10	--	14
20-29	4	10	--	14
30-39	5	5	--	10
40-54	1	6	--	7
55-64	1	4	--	5
> 64	1	4	--	5
TOTAL	20	47	--	67

* Total Number of Intersections = 14

TABLE A-10

Number of Pedestrian Accidents by Age Group and by Traffic Control
(Outside City Limits)
1988-1990
All Intersections with No Traffic Control*

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	10	62	--	72
15-19	2	23	--	25
20-29	1	14	--	15
30-39	3	13	--	16
40-54	1	14	--	15
55-64	1	7	--	8
> 64	2	7	--	9
TOTAL	20	140	--	160

* Total Number of Intersections = 72

TABLE A-11

Number of Pedestrian Accidents by Age Group and by Type of Facility
(Within City Limits)
1988-1990
Two-Way, Non-Divided*

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	20	102	44	166
15-19	3	33	12	48
20-29	8	71	17	96
30-39	7	44	14	65
40-54	10	26	9	45
55-64	4	22	2	28
> 64	2	20	5	27
TOTAL	54	318	103	475

* Total Number of Locations = 166

TABLE A-12

Number of Pedestrian Accidents by Age Group and by Type of Facility
(Within City Limits)
1988-1990
Divided Partial Control*

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	1	15	5	21
15-19	1	10	3	14
20-29	3	17	10	30
30-39	2	21	9	32
40-54	3	17	3	33
55-64	3	3	0	6
> 64	2	8	2	12
TOTAL	15	91	32	138

* Total Number of Locations = 32

TABLE A-13

Number of Pedestrian Accidents by Age Group and by Type of Facility
(Outside City Limits)
1988-1990
Two-Way, Non-Divided*

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	24	138	132	294
15-19	8	58	55	121
20-29	14	45	87	146
30-39	15	46	69	130
40-54	14	47	56	117
55-64	2	17	12	31
> 64	6	26	29	61
TOTAL	83	377	440	900

* Total Number of Locations = 294

TABLE A-14

Number of Pedestrian Accidents by Age Group and by Type of Facility
(Outside City Limits)
1988-1990
Divided Partial Control*

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	0	3	6	9
15-19	1	1	3	5
20-29	2	8	1	11
30-39	0	3	1	4
40-54	0	3	4	7
55-64	0	2	2	4
> 64	0	1	0	1
TOTAL	3	21	17	41

* Total Number of Locations = 11

TABLE A-15

Number of Pedestrian Accidents by Age Group and by Alcohol Effect
(Within City Limits)
1988-1990
Drinking and Obviously Drunk

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	1	0	1	2
15-19	1	1	2	4
20-29	0	4	6	10
30-39	2	8	6	16
40-54	1	9	3	13
55-64	0	3	0	3
> 64	0	1	0	1
TOTAL	5	26	18	49

TABLE A-16

Number of Pedestrian Accidents by Age Group and by Alcohol Effect
(Outside City Limits)
1988-1990
Drinking and Obviously Drunk

AGE GROUP	ACCIDENT LOCATION			TOTAL
	WITHIN INTERSECTION	WITHIN 150 FT FROM STOP LINE	MID-BLOCK	
≤ 14	0	0	2	2
15-19	1	4	6	11
20-29	4	9	21	34
30-39	5	15	24	44
40-54	4	6	13	23
55-64	1	3	2	6
> 64	0	0	1	1
TOTAL	15	37	69	121