Standard Title Page — Report on State Project

Report No.	Report Date	No. Pages	Type Report:	Project No. :
VTRC 91–R30	June 1991	41 pages	Final Period Covered: 1985–1987	9241–062–940 Contract No. :

Title and Subtitle

Factors Associated with Fatal Pedestrian Crashes in Virginia's Urban Areas: 1985–1987

Key Words

Fatalities
Pedestrians

Author(s)

Michael E. Worthington

Performing Organization Name and Address:

Virginia Transportation Research Council
Box 3817, University Station
Charlottesville, Virginia 22903-0817

Sponsoring Agencies' Names and Addresses

Virginia Department of Transportation
1401 E. Broad Street
Richmond, Virginia 23219

University of Virginia
Charlottesville
Virginia 22903

Supplementary Notes

Project funded by: Department of Motor Vehicles
P.O. Box 27412
Richmond, VA 23269

Abstract

Between 1985 and 1987, a total of 400 pedestrians were fatally injured in Virginia; more than half of the pedestrian fatalities occurred in an urban area of the Commonwealth. Because little research had been conducted on urban pedestrian fatalities in Virginia, the Virginia Department of Motor Vehicles requested that the Virginia Transportation Research Council investigate the Commonwealth's urban pedestrian fatalities during the period 1985 to 1987. The purpose of the study was to identify situations and characteristics associated with urban pedestrian fatalities and, subsequently, to use the information to develop pedestrian safety measures. The study includes a literature review; an examination of accident reports of fatal pedestrian crashes occurring during the study period; and an analysis of pedestrian characteristics, driver actions, roadway and environmental factors, and vehicle factors present in the crashes.

Overall, negligent pedestrian behavior contributed to urban pedestrian fatalities more than factors related to driver behavior, the roadway and environment at the crash site, or the vehicle itself. Alcohol use by the pedestrian was also found to be a major factor in urban pedestrian fatalities. High-risk periods are the end of the week and weekends, late afternoon to late evening, darkness, and fall and winter. Elderly pedestrians have greater difficulty negotiating complex situations and are more likely than younger persons to be fatally injured when struck by a vehicle. Across all age groups, males have a higher fatality rate.

FINAL REPORT

FACTORS ASSOCIATED WITH FATAL PEDESTRIAN CRASHES IN VIRGINIA'S URBAN AREAS: 1985–1987

Michael E. Worthington
Research Scientist

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

Virginia Transportation Research Council
(A Cooperative Organization Sponsored Jointly by the Virginia Department of Transportation and the University of Virginia)

Charlottesville, Virginia

June 1991
VTRC 91-R30

SAFETY RESEARCH ADVISORY COMMITTEE

W. H. LEIGHTY, Chairman, Deputy Commissioner, Department of Motor Vehicles

C. W. LYNN, Executive Secretary, Research Scientist, VTRC

J. L. BLAND, Chief Engineer, Department of Aviation

R. J. BREITENBACH, Director, Transportation Safety Training Center, Virginia Commonwealth University

MAJ. J. K. COOKE, Asst. Chief of Law Enforcement, Department of Game and Inland Fisheries

S. H. COOPER, Director of Rail and Public Transportation, VDOT

M. L. EDWARDS, Executive Assistant, Office of the Secretary of Transportation

W. S. FELTON, JR., Administrative Coordinator, Commonwealth's Attorneys' Services and Training Council

P. D. FERRARA, Ph.D., Director, Division of Forensic Sciences, Dept. of General Services

D. R. GEHR, Asst. Chief Engineer, VDOT

LT. COL. L. A. GRAHAM, Director, Bureau of Field Operations, Dept. of State Police

J. T. HANNA, Special Assistant to the Commissioner, Department of Motor Vehicles

C. P. HEITZLER, JR., Program Manager, Department of Information Technology

T. A. JENNINGS, Safety/Technology Transfer Coordinator, Federal Highway Administration

B. G. JOHNSON, Supervisor, Driver Education, Department of Education

SGT. P. J. LANTEIGNE, Operations & Tactics Bureau, Virginia Beach Police Dept.

W. T. McCOLLUM, Executive Director, Commission on VASAP

S. D. McHENRY, Director, Division of Emergency Medical Services, Dept. of Health

CAPT. R. P. MINER, Commander, Traffic Division, Fairfax County Police Dept.

COMM. S. E. NEWTON, Patrol Division, Albemarle County Police Department

J. T. PHIPPS, Director, Roanoke Valley ASAP

F. F. SMALL, Asst. State Traffic Engineer, VDOT

J. A. SPENCER, ESQ., Asst. Attorney General, Office of the Attorney General

E. W. TIMMONS, Director of Public Affairs, Tidewater AAA of Virginia

A. R. WOODROOF, ESQ., Manakin-Sabot, Virginia

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Introduction

In 1988, the Virginia Department of Motor Vehicles requested that the Virginia Transportation Research Council conduct a study of pedestrian fatalities on Virginia's roadways. This report presents the first of two phases of the study and attempts to identify situations and characteristics that lead to pedestrian fatalities in Virginia's urban areas. The research analyzes fatal pedestrian crashes in Virginia's urban areas from 1985 through 1987. Data were collected from police accident reports and were analyzed using the computer program Statistical Package for the Social Sciences (SPSS). In Virginia, 400 pedestrians were fatally injured during the 3-year study period. Of these, 216 (54%) fatalities occurred in urban areas and are the subject of this report.

Findings

The primary factor contributing to fatal pedestrian crashes was the influence of alcohol and/or other drugs on the pedestrian: 34% of the involved pedestrians were under the influence of alcohol and/or other drugs. In the 20–65 age group, at least 50% of the males had been drinking and/or taking other drugs as compared with 27% of the females. At least 50% of the pedestrians who had alcohol in their blood had a blood alcohol concentration (BAC) of 0.20% or higher, with the exception of those pedestrians under age 20 or over age 75.

Older pedestrians were most at risk when crossing the street. Fifty-five percent of the pedestrians were crossing the street when struck by a vehicle, whereas 16% were walking on or along the roadway. Those pedestrians age 55 or older were approximately 7 times more likely to be struck by a vehicle while crossing the street than while walking on or along the roadway. Those under age 20, however, were only 2 times as likely to be struck while crossing the street than while walking on or along the roadway.

The largest proportion (17%) of fatal pedestrian crashes occurred in October. The two seasons with the greatest proportion of crashes were fall (36%) and winter (26%). The largest concentration of crashes (approximately 60%) occurred between 4 p.m. and midnight. Younger pedestrians (under age 25) tended to be struck between 4 p.m. and 8 p.m. (38%). Older pedestrians tended to be struck during the day (i.e., between 8 a.m. and 8 p.m.), with 65% of those age 55 or older being struck during these hours. The largest concentration of crashes (57%) occurred from Thursday through Saturday.

In all age groups, the fatality rate was higher for males: 1.0 per 10,000 for males and 0.3 per 10,000 for females. Among males, the fatality rates for

teenagers, young adults (age 20–24) and older males (age 55+) were 4 to 5 times higher than those for females in the same age group.

In terms of driver factors, younger drivers and male drivers were overrepresented. In 53% of the crashes, the driver was between 20 and 34 years of age. Beginning drivers (age 16–19) were the most overrepresented, comprising 6% of the driver population but involved in 11% of the crashes. Male drivers, although comprising 51% of licensed urban drivers, were drivers in 68% of the crashes.

Drivers were cited for violating traffic laws in only 36% of the crashes, and the most frequent violation (33%) was hit-and-run. The driver was also more frequently sober than the pedestrian; approximately 80% of the drivers had not been drinking prior to the crash, and less than 10% were impaired.

Lighting appeared to be more of a factor than weather. Weather conditions were clear at the time of 65% of the crashes. However, 66% of the crashes occurred during darkness, and 58% of those occurred at sites where the roadway was not lighted.

In terms of vehicle and road factors, the vehicle that struck the pedestrian was proceeding straight ahead at the time of 87% of the crashes and was traveling at least 40 mph at the time of nearly 50% of the crashes. Approximately 75% of the crash sites were straight, level roadways, and approximately 52% were within 150 feet of an intersection.

Conclusions

1. Negligent pedestrian behavior contributed to the occurrence of fatal pedestrian crashes more than factors associated with the driver of the vehicle, the roadway and environment at the crash site, and the vehicle itself.

2. Alcohol and/or other drug use by the pedestrian is a major contributing factor in fatal pedestrian crashes except for crashes involving pedestrians under age 20 or age 55 or older.

3. The higher a pedestrian's BAC, the more likely the pedestrian is to be involved in a fatal crash.

4. The end of the week and weekends are high risk periods for involvement in a fatal pedestrian crash, particularly during the period from late afternoon to late evening. However, elderly pedestrians are less at risk during this period than are pedestrians in other age groups.

5. The risk of fatal pedestrian crashes is greater during darkness. However, there are age-related differences in the level of risk throughout the day.

6. Elderly pedestrians encounter greater difficulty than younger persons in the negotiation of potentially complex situations, such as crossing the street in a

densely populated urban area. They are also more likely to die as a result of the impact.

7. Males engage in risk-taking behavior to a greater degree than females.

8. The statistics for Virginia are similar to those for other states that have studied their urban fatal pedestrian crash problem. The exception is Virginia's lower fatality rate among young children.

Recommendations

1. Investigate further the relationships between pedestrian behaviors and driver behaviors in urban areas, with emphasis on determining differences among age groups and between sexes.

2. Explore the feasibility of developing an ongoing program directed toward developing measures to prevent fatal injury in urban areas that can be taken by both pedestrians and drivers.

3. Explore traffic engineering enhancements that might improve urban pedestrian safety.

4. Through research, determine the elements of effective child pedestrian safety programs in Virginia's urban areas and incorporate them into programs that focus on pedestrian safety among the elderly.

FINAL REPORT

FACTORS ASSOCIATED WITH FATAL PEDESTRIAN CRASHES IN VIRGINIA'S URBAN AREAS: 1985–1987

Michael E. Worthington
Research Scientist

INTRODUCTION

The history of crashes involving pedestrians and motor vehicles in the United States extends back to the latter part of the 19th century. The first recorded traffic fatality occurred in New York City in 1899—and the victim was a pedestrian (American Automobile Association [AAA], 1987).

In 1933, there were 12,840 pedestrian fatalities in the United States: 41% of all traffic fatalities. This level of fatalities continued until 1946, when pedestrian deaths declined to 34% of all traffic fatalities. In 1952, pedestrians comprised 24% of traffic fatalities. By 1965, pedestrian fatalities had decreased to 18% and have remained at approximately this level since then.

Pedestrian crashes occur primarily in urban areas. Approximately 83% of all pedestrian-vehicle crashes and 74% of pedestrian fatalities in the United States in 1985 occurred in urban areas (Zegeer & Zegeer, 1988). One study in Maryland (Bush, 1985) found that 93% of pedestrian crashes from 1974 through 1979 occurred in either urban or suburban areas. In North Carolina, Linder et al. (1975) found that fatally injured pedestrians accounted for 30% of the state's urban traffic deaths in 1973 and 1974. According to Senevirante and Fraser (1987), the primary objective of pedestrians in urban areas is movement between two points by the shortest path; factors such as protection from weather, congestion-free sidewalks, and safety are secondary concerns.

PURPOSE AND SCOPE

The purpose of this study was to analyze the factors that are associated with fatal pedestrian crashes in the urban areas of Virginia. The study identifies factors associated with the pedestrian, the driver of the striking vehicle, the roadway and environment, and the vehicle itself. The information presented herein will be used in the second phase of this study, which will focus on the development of pedestrian safety measures in Virginia's urban areas.

METHODOLOGY

In order to analyze the factors associated with fatal pedestrian crashes in Virginia's urban areas, the accident reports of the investigating police officers for fatal pedestrian crashes occurring from 1985 through 1987 were examined and coded. Cross-tabulations were performed to ascertain associated pedestrian characteristics, driver actions, roadway and environmental factors, and vehicle factors. U.S. census data were used to identify the urban areas in Virginia.

In some cases, data included on accident reports were further investigated subsequent to the submission of the reports and, as a result, additional data were obtained. Specifically, in instances where the officer indicated that a pedestrian's or a driver's blood alcohol concentration (BAC) was either "unknown" or "not drinking," subsequent toxicology reports submitted by the medical examiner were reviewed. In those cases where the examiner's report supplemented the accident report with more accurate information, data on BAC levels reported by the examiner were used. To be consistent with Virginia law, a BAC level of less than 0.05% was coded as "drinking, ability not impaired," 0.05% to 0.10% was coded as "drinking, impairment unknown," and 0.10% or higher was coded as "drinking, ability impaired."

LITERATURE REVIEW

The following factors associated with fatal pedestrian crashes were reviewed:

1. the pedestrian
2. the driver of the striking vehicle
3. the roadway and environment
4. the striking vehicle.

The Pedestrian

Age

Most research conducted in the United States indicates that the young and the elderly are more involved in fatal pedestrian crashes than are other age groups. Based on crash data from more than 1,900 cities, AAA found that children in the 2–14 age group, particularly ages 5 and 6, were overrepresented in pedestrian crashes compared with their number in the general population (Pfefer et al., 1982). Another study that used data from 1977 through 1982 gathered at 317 signalized intersections in urban areas of the United States reported that 15% of the fatally

injured pedestrians were under age 14 and 21% were at least 65 (Zaidel & Hocherman, 1987). Additional research conducted in the United States and other countries indicated that young people and the elderly are overrepresented in fatal pedestrian crashes (AAA, 1984; Itoh, 1979; Knoblauch et al., 1978; Linder et al., 1975; Preusser, 1988; Tsongos, 1984; Wilson & Grayson, 1980).

Explanations for the overrepresentation of young pedestrians have been offered by several investigators. These explanations have in common a focus on the behavioral characteristics particular to young children. A few investigators have contended that children who become involved in all types of accidents, not just those that are traffic related, may not be representative of children at a given developmental level. Such children have been described as daring, overactive, impulsive, and extroverted (Husband & Hinton, 1972; Manheimer & Mellinger, 1967; Salk, 1973; Viney, 1971) and have more frequent behavioral and emotional problems than the rest of the population (Burton, 1968; Krall, 1953; Manheimer & Mellinger, 1967). They have also been classified as more aggressive and more attention seeking, with poor interpersonal skills (Burton, 1968; Manheimer & Mellinger, 1967; Viney, 1971). Essentially, young children, by their nature, are more prone to accidents.

The vulnerability of older persons in fatal pedestrian crashes has also been addressed. In crashes where pedestrians are struck by the front of a vehicle, the elderly appear more likely to sustain serious injury than younger adults at a comparable impact speed (Ashton et al., 1977). In addition, the elderly are more likely than other adults to employ a strategy for crossing the street that places them more at risk. For example, they may delay before crossing the street, spend more time at the curb, take longer to cross the road, and make more head movements before and during crossing (Wilson & Grayson, 1980). These characteristics combine to make the elderly particularly vulnerable to pedestrian crashes.

Several state studies have shown that age groups other than the young and the elderly are overrepresented in fatal pedestrian crashes. In Maryland, Bush (1985) examined statewide data on fatal pedestrian crashes that occurred from 1974 through 1979 and found that the 20–29 age group, representing 19% of the state's population, comprised 32% of fatally injured pedestrians. Similarly, in their analysis of pedestrian crashes in Montreal, Senevirante and Shuster (1989) found that the greatest number of pedestrians involved in fatal crashes were in the 20–29 age group.

Sex

Male pedestrians in all age groups are significantly overrepresented in fatal pedestrian crashes. According to Fell and Toth (1981), male pedestrians account for 70% of the fatalities and have 2 to 3 times the death rate per million population as female pedestrians. Robertson et al. (1977), in their analysis of urban intersection pedestrian crashes from four data bases covering more than 5,300 cases, had similar results. Knoblauch et al. (1978) analyzed fatal pedestrian crashes occurring on freeways in five states and found that 83% of the casualties were male.

Explanations for the overrepresentation of males focus on sex-related differences in behavior. Apparently, males take more risks, are at risk more often, and have a higher drinking rate than females (Fell & Toth, 1981).

Major Contributing Factors

The major factors most frequently cited in the literature that contribute to fatal pedestrian crashes are risk-taking behavior by the pedestrian and the influence of alcohol and/or other drugs on the pedestrian.

In their study of fatal pedestrian crashes occurring on freeways, Knoblauch et al. (1978) found that, at least one causal factor was specified in the accident report in 97% of the crashes. The most frequently cited factor was risk-taking behavior by the pedestrian, such as pushing a vehicle in the roadway, lying in the roadway, and repairing a vehicle that had broken down. The National Safety Council (1988) cited a Maryland study conducted in the early 1980s that indicated pedestrian crash victims on 55 mph roadways were generally in one of the following categories: disabled motorists, maintenance workers, hitchhikers or joggers, people illegally walking or standing beside the roadway, riders waiting for prearranged pickups, and people who dart unexpectedly in front of traffic—sometimes disabled motorists, but often intoxicated persons or individuals with psychiatric disorders.

The use of alcohol by adult pedestrians is a major factor. Preusser (1988) reported that as many as 50% of all fatally and seriously injured adult pedestrians were drinking prior to being struck by the vehicle. In one study in New Orleans (Blomberg et al., 1979), 50% had been drinking and their BAC was extremely high—approximately 50% of those who had been drinking had a level of at least 0.20%. Several other studies have also reported that pedestrian drinking is a major factor in adult pedestrian crashes (Blomberg et al., 1979; Fell & Toth, 1981; Marsden, 1972; Snyder, 1972).

Frequently, pedestrians involved in fatal crashes who have been drinking are middle-aged males who have a variety of personal and social problems. Generally, they are struck by a motor vehicle at night or on weekends (Snyder, 1972). According to AAA (1970), pedestrians involved in fatal crashes who are between the ages of 35 and 44 appear to be the major group showing alcohol involvement. Alcohol is not a significant factor among pedestrians over age 65.

Time of Day

The time of day fatal pedestrian crashes occur has received considerable attention in the literature. Generally, most research concludes that the largest proportion of fatal crashes occur during the period from midafternoon to midevening.

Pfefer et al. (1982) found that the number of crashes in urban areas peaked during the period from 3 p.m. to 6 p.m. (30% to 40%); smaller peaks occurred between 7 a.m. and 9 a.m. and between noon and 1 p.m. Robertson et al. (1977) found that the most dangerous time of day for pedestrians crossing at intersections was

between 3 p.m. and 6 p.m. In Montreal, Senevirante and Shuster (1989) found that over 40% of the crashes occurred between noon and 6 p.m., with more than 22% of all crashes occurring in the afternoon peak (3 p.m. to 6 p.m.) and 20% occurring in the afternoon off-peak (noon to 3 p.m.).

Several investigators have contended that pedestrian crashes which occur during darkness are more severe than those that occur during daylight hours. Linder et al. (1975) found that 60% of pedestrian crashes occurred during daylight hours but that those which occurred at night were more severe. In fact, although only 32% of the pedestrian crashes occurred during darkness, 60% of the fatal crashes occurred after dark. Thus, although more crashes occur during daylight, a far greater percentage of the nighttime crashes are fatal. Farmer (1968) found that 54% of Canada's fatal pedestrian crashes occurred at night. He attributed this to the inability of drivers to see pedestrians because of the darkness.

Other investigators have reported that fatal crashes involving alcohol-impaired pedestrians almost always occur at night (Blomberg et al., 1979; Simpson & Warren, 1979; Tell & Hazzard, 1985).

Day of Week

Much of the literature indicates that the majority of fatal pedestrian crashes occur on Friday (Illinois Department of Public Works and Buildings, 1966; Kraay, 1976; Linder et al., 1975; Robertson et al., 1977; Senevirante & Shuster, 1989). Weekends (i.e., Saturday and Sunday) are also frequently cited as the days on which fatal pedestrian crashes are common (Blomberg et al., 1979; Simpson & Warren, 1979).

Month

The greatest proportion of fatal pedestrian crashes typically occur in the fall and winter months, when there is less daylight. October and December are frequently cited as the months in which the largest proportion of fatal crashes occur (Blomberg et al., 1979; Bush, 1985; Illinois Department of Public Works and Buildings, 1966; Linder et al., 1975; Senevirante & Shuster, 1989; Zegeer & Zegeer, 1988).

The Driver

Most research points out that the driver is not at fault in the majority of fatal pedestrian crashes. Zegeer's and Deen's (1976) study of fatal pedestrian crashes in Kentucky found that the driver was typically speeding or driving recklessly when the driver was at fault. Marsden's (1972) study of alcohol-related pedestrian fatalities found that 64% of the drivers involved were reported to have been traveling at or below the posted speed limit at the time of the collision.

Linder et al. (1975) reported that 21% of the male drivers involved in fatal pedestrian crashes in North Carolina were in the 16–20 age group. Almost 50% were aged 30 or younger. After age 20 and up to age 70, the proportion of crash involvement decreased as age (grouped in 5-year increments) increased for both male and female drivers—the only exception was males in the 46–50 age group.

The Roadway and Environment

The type of roadway, intersection-related factors, speed limit, and weather and lighting conditions play a part in the frequency and severity of fatal pedestrian crashes. In general, crash sites are straight, level roadways (Zegeer & Deen, 1976; Kraay, 1976).

Fell and Toth (1981) reported that 8% of fatal pedestrian crashes occurred on limited access highways, although only 2% of all pedestrian crashes occurred on such highways. Approximately 45% of the fatal crashes occurred on other major roadways, although only 20% of all pedestrian crashes occurred on such roadways. Local roads accounted for at least 75% of all pedestrian crashes but less than 50% of fatal pedestrian crashes.

The posted speed limit at the site of the fatal crash is generally high. Fell and Toth (1981) reported that one-third of fatal pedestrian crashes in the United States occurred on high-speed roads and that more than 90% occurred at speeds greater than 30 mph. Knoblauch et al. (1978) found that the posted legal speed limit at most crash sites on freeways was 55 mph, but the estimated preinvolvement and impact speeds were 47.4 mph and 39.8 mph, respectively.

Approximately 20% of fatal pedestrian crashes in the United States occur at intersections (Fell & Toth, 1981). Robertson et al. (1977), in their analysis of fatal pedestrian crashes in urban areas, found that 40% to 50% of the crashes occurred at intersections controlled by traffic signals. In several studies in the United States and Israel, Zaidel and Hocherman (1987) reported that the majority of fatal pedestrian crashes at signalized intersections involved vehicles that were proceeding straight ahead. Zegeer and Deen (1976) in their Kentucky study reported that, although 20% of fatal pedestrian crashes occurred at intersections, only one-third of them involved an illegal crossing.

Weather and visibility conditions are also factors. Simpson and Warren (1979) analyzed a sample of 734 fatal pedestrian crashes in Canada and found that the majority of pedestrians were killed in clear weather. Knoblauch et al. (1978) found that only 15% of the fatal crashes occurred during rain, snow, or reduced visibility conditions. They further reported that 66% occurred during dark or twilight conditions, two-thirds of which were at night on an unlighted roadway. Ehrlich et al. (1982) reported that poor visibility, or lack of conspicuity, has been identified as a contributing causal factor in a large number of fatal pedestrian crashes during both the day and the night in U.S. urban areas.

The Vehicle

Most research indicates that passenger cars and light trucks are the most common types of vehicles that strike pedestrians. Kraay (1976) analyzed fatal pedestrian crashes that occurred in The Netherlands from 1968 through 1972 and found that fatalities resulted primarily from collisions with passenger cars and secondarily from collisions with light trucks. Knoblauch et al. (1978) reported that most of the striking vehicles in freeway crashes were full-sized passenger cars.

However, the heavier the striking vehicle, the more likely it is that the pedestrian will be killed. Fell and Toth (1981) reported a strong relationship between vehicle weight and pedestrian fatality. Vehicles that weigh in excess of 3,500 pounds are twice as likely to be involved in a fatal pedestrian crash than vehicles weighing from 1,500 to 2,000 pounds. Similar ratios hold true for trucks and buses.

ANALYSIS

Fatal pedestrian crashes in Virginia's urban areas for the period 1985 through 1987 were analyzed. According to 1980 U.S. census data, an urban area is defined as any county, city, or incorporated town with a population of at least 2,500 and with at least 50% of the population residing in the urbanized portion of the jurisdiction. In 1980, a total of 3.5 million people lived in the 41 cities and 10 counties in Virginia that met this definition. Virginia's urban jurisdictions are listed in the appendix.

Pedestrian Factors

Number

During the study period, 400 fatal pedestrian crashes occurred in Virginia. Of this number, 216 crashes (54.1%) occurred in an urban area. The fatality rate was 0.6 per 10,000 urban population.

Age

The largest number of fatal pedestrian crashes (40) involved victims in the 25–34 age group, followed by those in the 55–64, 20–24, 65–74, and 75+ age groups, respectively (see Figure 1). Although these five age groups comprised only 46.9% of Virginia's urban population, they were involved in 62.8% of the crashes. The proportion of fatalities among the 20–24 and 25–34 age groups approximated their distribution among the urban population; however, the 55–64, 65–74, and 75+ age groups were overrepresented. All other age groups were underrepresented (see Table 1).

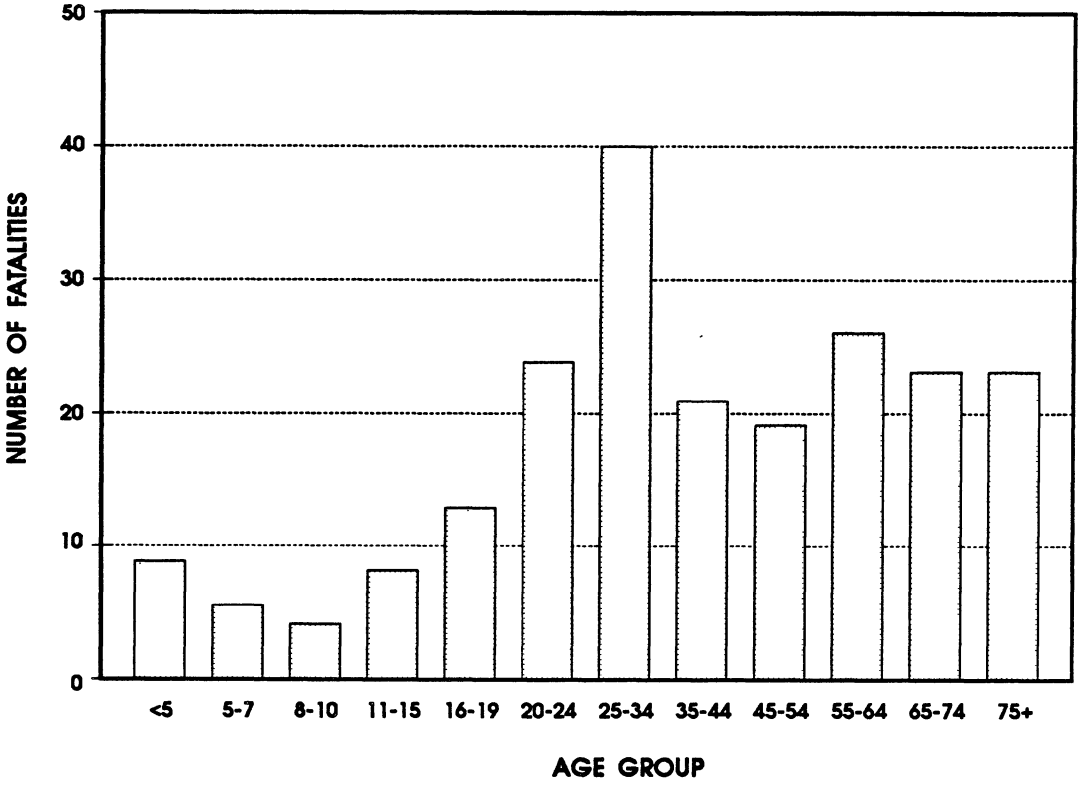

Figure 1. Pedestrian Fatalities by Age.

Table 1

Percentage of Urban Population, Percentage of Fatal Urban Pedestrian Crashes, and Urban Fatality Rates by Age

AGE GROUP	% OF URBAN POPULATION	% OF FATAL URBAN CRASHES	FATALITY RATE*
<5	6.7	4.2	0.4
5–7	3.9	2.8	0.4
8–10	4.6	1.9	0.2
11–15	7.8	3.7	0.3
16–19	7.7	6.0	0.5
20–24	11.0	11.1	0.6
25–34	18.2	18.5	0.6
35–44	12.3	9.7	0.5
45–54	10.0	8.8	0.5
55–64	8.9	12.0	0.8
65–74	5.5	10.6	1.2
75+	3.3	10.6	2.0
TOTAL	100.0**	100.0**	0.6

*Per 10,000 urban population.
**Does not total 100.0 due to rounding.

Among fatally injured pedestrians under age 16, the rate (per 10,000 urban population) ranged from 0.2 for the 8–10 age group (the lowest among all age groups) to 0.4 for the 5–7 age group. The rate varied from 0.5 to 0.6 for those between 16 and 54 years. The rate increased to 0.8 for the 55–64 age group, increased again to 1.2 for the 65–74 age group, and peaked at 2.0 for the 75+ age group (see Table 1). Thus, for pedestrians 65 or older, the rate of fatal injury was dramatically increased.

Sex and Age

Although males made up 48.6% of Virginia's urban population, they comprised 77.3% of fatally injured pedestrians in urban areas (see Table 2). In addition, the number of male pedestrians exceeded the number of female pedestrians in all age groups. Further, male pedestrians were overrepresented in virtually all age groups, and female pedestrians were underrepresented when compared with their distribution among the urban population. The sole exception was children under age 5, where fatality and population proportions were similar.

When pedestrian fatality rates were examined by sex and age of the pedestrian, the rates for males were consistently higher than those for females. For males, the rate doubled from 0.4 for those under age 5 to 0.8 for those aged 5–7. For ages 8–15, the rate declined. At age 16, the rate began to increase and leveled off (1.0) for ages 20–34, declining slightly at age 35 and remaining steady until age 55, when the rate began to increase dramatically (1.4).

Among female pedestrians, the rate declined from 0.3 for those under age 5 to 0.0 for age groups 5–7 and 8–10 and then climbed slightly (0.2) and remained fairly stable through age 44. At age 45, the rate began to increase gradually, with a dramatic increase to 0.7 for the 65–74 age group and a peak at 1.0 for ages 75+.

Major Contributing Factors

The primary factor that contributed to fatal pedestrian crashes was the influence of alcohol and/or other drugs on the pedestrian (the major factor in 34.2% of the fatal crashes). Pedestrian inattention or error was the second most frequently cited factor (see Table 3).

Approximately 41% of the pedestrians had been drinking prior to the time they were struck by the vehicle. Of those pedestrians whose BAC was reported, 85.9% had a BAC of at least 0.10% and 57.7% had a BAC of 0.20% or higher (see Table 4 and Figure 2).

Male pedestrians were more likely to have been drinking and alcohol impaired than female pedestrians (see Table 5). Approximately 45% of male pedestrians and 28% of female pedestrians had been drinking. Of the 70 male pedestrians who had been drinking, slightly more than 84% were impaired.

The majority of pedestrians aged 20–64 had been drinking prior to being struck by the vehicle (see Figure 3). Alcohol involvement was comparatively low among the other age groups. No pedestrians under age 16 had been drinking.

Table 2

Number of Fatalities, Percentage of Total Fatalities, Percentage of Urban Population, and Fatality Rates per 10,000 Urban Population by Sex and Age

AGE GROUP	MALE				FEMALE			
	NO. OF FATALITIES	% OF TOTAL FATALITIES	% OF URBAN POPULATION	FATALITY RATE	NO. OF FATALITIES	% OF TOTAL FATALITIES	% OF URBAN POPULATION	FATALITY RATE
<5	5	55.6	51.1	0.4	4	44.4	48.9	0.3
5–7	6	100.0	50.8	0.8	0	0.0	49.2	0.0
8–10	4	100.0	50.9	0.5	0	0.0	49.1	0.0
11–15	6	75.0	50.6	0.4	2	25.0	49.4	0.1
16–19	11	84.6	51.2	0.8	2	15.4	48.8	0.2
20–24	21	87.5	51.7	1.0	3	12.5	48.3	0.2
25–34	33	82.5	49.2	1.0	7	17.5	50.8	0.2
35–44	17	81.0	49.4	0.8	4	19.0	50.6	0.2
45–54	13	68.4	48.2	0.8	6	31.6	51.8	0.3
55–64	21	80.8	46.4	1.4	5	19.2	53.6	0.3
65–74	15	65.2	40.9	1.9	8	34.8	59.1	0.7
75+	15	65.2	30.7	4.2	8	34.8	69.3	1.0
TOTAL	167	—	48.6	1.0	49	—	51.4	0.3

Table 3

Major Contributing Factors

MAJOR FACTORS	NO.	%*
Pedestrian under influence of alcohol and/or other drugs	63	34.2
Pedestrian inattention or error	42	22.8
Driver inattention or error	20	10.9
Pedestrian and driver under influence of alcohol and/or other drugs	17	9.2
Driver under influence of alcohol and/or other drugs	13	7.1
Driver speeding	9	4.9
Other factors**	20	10.9
Not stated	32	—
TOTAL	216	100.0

*Excludes "not stated."

**Includes driver handicap, weather or visibility conditions, slick road, pedestrian handicap, and miscellaneous.

Table 4

Involvement of Alcohol Among Pedestrians

ALCOHOL INVOLVEMENT	NO.	%*
Had not been drinking	120	59.1
Drinking—impaired	68	33.5
Drinking—not impaired or not known if impaired	15	7.4
Not stated	13	—
TOTAL	216	100.0

*Excludes "not stated."

Table 5

Number and Percentage of Pedestrians by Sex and Alcohol Involvement

	MALE		FEMALE		TOTAL	
ALCOHOL INVOLVEMENT	NO.	%	NO.	%	NO.	%*
Had not been drinking	86	55.1	34	72.3	120	59.1
Drinking—impaired	59	37. 8	9	19.1	68	33.5
Drinking—not impaired *or* not known whether impaired	11	7.1	4	8.5	15	6.9
Not stated					13	—
TOTAL	156	100.0	47	100.0	216	100.0

*Excludes "not stated."

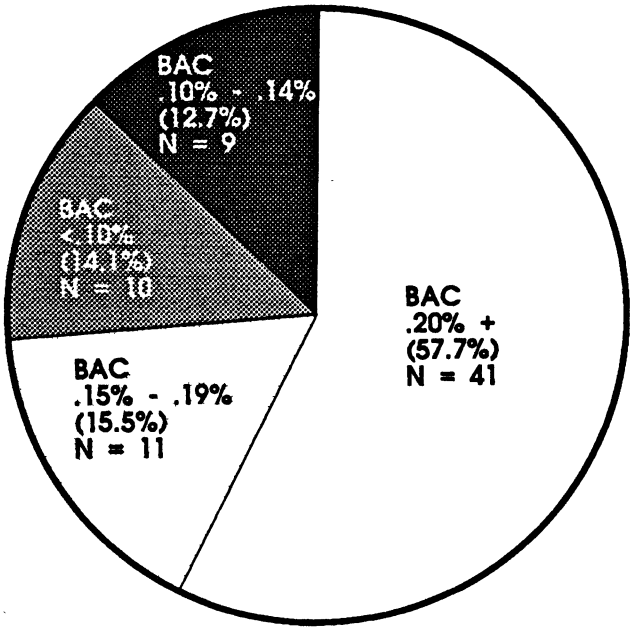

Figure 2. BAC of Pedestrians Whose Level Was Reported.

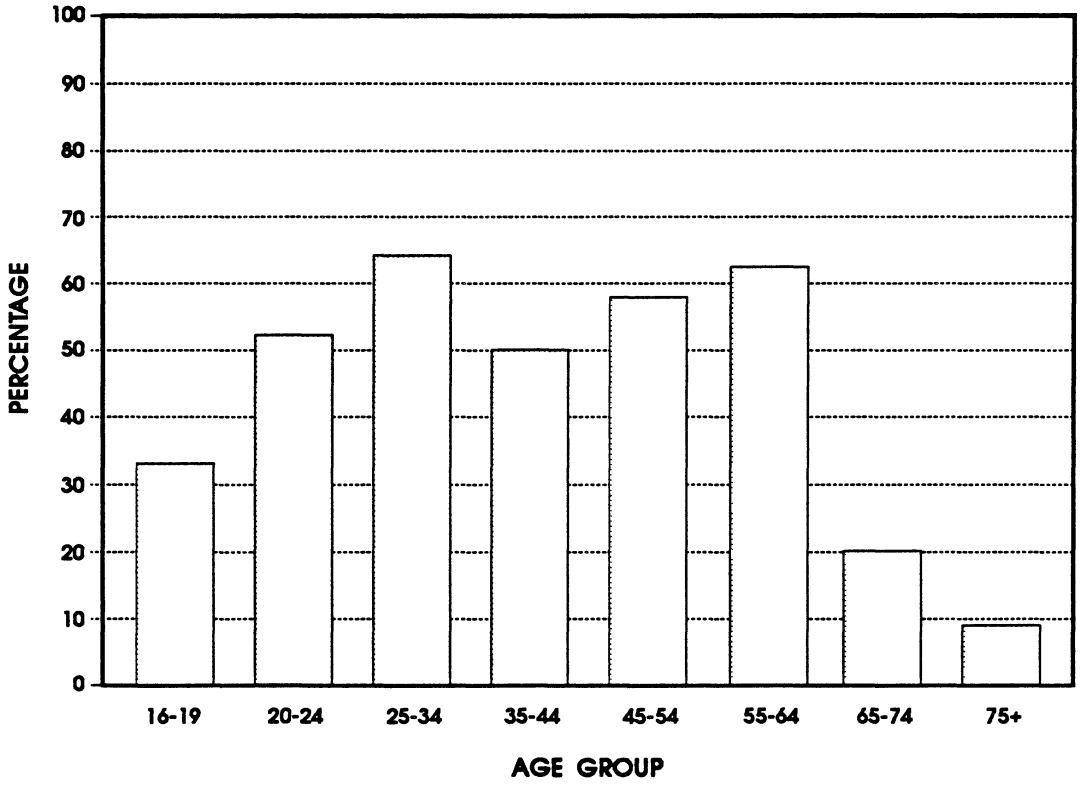

Figure 3. Percentage of Pedestrians by Age Who Had Been Drinking.

Table 6

Number and Percentage of Pedestrians
by Age, Sex, and Alcohol Involvement

AGE GROUP	MALES			FEMALES			TOTAL
	DRINKING	NOT DRINKING	TOTAL	DRINKING	NOT DRINKING	TOTAL	
16–19	3 30.0%	7 70.0%	10 100.0%	1 50.0%	1 50.0%	2 100.0%	12
20–24	10 50.0%	10 50.0%	20 100.0%	2 66.7%	1 33.3%	3 100.0%	23
25–34	22 68.8%	10 31.2%	32 100.0%	3 42.9%	4 57.1%	7 100.0%	39
35–44	8 50.0%	8 50.0%	16 100.0%	2 50.0%	2 50.0%	4 10.0%	20
45–54	9 69.2%	4 30.8%	13 100.0%	2 50.0%	4 50.0%	6 100.0%	19
55–64	13 65.0%	7 35.0%	20 100.0%	2 50.0%	2 50.0%	4 100.0%	24
65–74	4 33.3%	8 66.7%	12 100.0%	0 0%	8 100.0%	8 100.0%	20
75+	1 6.7%	14 93.3%	15 100.0%	1 14.3%	6 85.7%	7 100.0%	22
Not stated	——	——	——	——	——	——	37
TOTAL	70 50.7%	68 49.3%	138 100.0%	13 31.7%	28 68.3%	41 100.0%	216

Among male pedestrians, alcohol appears as a crash factor beginning in the 20–24 age group; 50% of this group had been drinking (see Table 6). From age 20 through 64, 61.4% had been drinking. At age 65, alcohol involvement declined considerably; only 18.5% aged 65 or older had been drinking. Among female pedestrians, the number of fatalities within age groups was generally too small to permit any meaningful analysis of alcohol involvement.

In analyzing BAC levels among pedestrians who had been drinking (see Table 7), it was found that 62.7% aged 20–64 had a BAC level of at least 0.20%. However, only four in the 16–19 and 75+ age groups had BAC results reported; thus any meaningful analysis of these age groups was precluded.

2274

Table 7

Number and Percentage of Pedestrians in Age Group by BAC

AGE GROUP	BAC .05%–.09%	.10%–.14%	.15%–.19%	.20%+	TOTAL*
16–19	1	1	0	1	3
	33.3%	33.3%	0%	33.3%	100.0%
20–24	1	1	2	5	9
	11.1%	11.1%	22.2%	55.6%	100.0%
25–34	3	4	3	10	20
	15.0%	20.0%	15.0%	50.0%	100.0%
35–44	0	1	1	5	7
	0%	14.3%	14.3%	71.4%	100.0%
45–54	0	0	2	9	11
	0%	0%	18.2%	81.8%	100.0%
55–64	0	2	2	8	12
	0%	16.7%	16.7%	66.7%	100.0%
65–74	1	0	0	3	4
	25.0%	0%	0%	75.0%	100.0%
75+	0	0	1	0	1
	0%	0%	100.0%	0%	100.0%
TOTAL	6	9	11	41	67
	9.0%	13.4%	16.4%	61.2%	100.0%

*Percentages may not total 100.0% due to rounding.

The majority of pedestrians (55.3%) were crossing the street at the time they were struck, and most of this group were crossing at a location other than an intersection (see Table 8). The second largest group (16%) were walking on or along the roadway. Males were overrepresented in the accidents. Although comprising only 48.6% of Virginia's urban population, they represented approximately 75% of pedestrians who were fatally injured while crossing the street and approximately 79% of those who were fatally injured while walking on or along the roadway.

In the analysis of differences among age groups (see Table 9), fatally injured pedestrians under age 20 were approximately 2.5 times as likely to be struck while crossing the street than while walking on or along the roadway. In contrast, pedestrians aged 55 or older were approximately 7 times as likely to be struck while crossing the street than while walking on or along the roadway, and middle-aged

Table 8

Number and Percentage of Pedestrians by Action of Pedestrian When Struck

PEDESTRIAN ACTION	NO.	%*	% MALE
Crossing street	114	55.3	74.6
Walking on/along roadway	33	16.0	78.8
Darting out	13	6.3	61.5
Not in roadway	13	6.3	76.9
Vehicle broke down	6	2.9	100.0
Previous accident	4	1.9	75.0
Working in roadway	4	1.9	100.0
Other	19	9.2	89.5
Not stated	10	—	—
TOTAL	216	100.0**	73.6

*Excludes "not stated."

**Does not total 100.0 due to rounding.

Table 9

Number and Percentage of Pedestrians by Age for Most Frequent Actions When Struck

AGE GROUP	NO.	PEDESTRIAN ACTION	
		CROSSING STREET	WALKING ON/ ALONG ROADWAY
<5	9	4 (44.4%)	0
5–7	6	3 (50.0%)	0
8–10	4	2 (50.0%)	0
11–15	7	2 (28.6%)	2 (28.6%)
16–19	11	3 (27.3%)	4 (36.4%)
20–24	22	5 (22.7%)	4 (18.2%)
25–34	39	17 (43.6%)	11 (28.2%)
35–44	21	11 (52.4%)	2 (9.5%)
45–54	18	12 (66.7%)	2 (11.1%)
55–64	26	18 (69.2%)	5 (19.2%)
65–74	20	17 (85.0%)	2 (10.0%)
75+	23	20 (87.0%)	1 (4.3%)
TOTAL	206	114 (55.3%)	33 (16.0%)

*Excludes 10 pedestrians for whom information was not specified on police report.

pedestrians aged 35–54 were nearly 6 times as likely to be struck while crossing the street than while walking on or along the roadway. Young adult pedestrians aged 20–34 were approximately 1.5 times as likely to be struck while crossing the street than while walking on or along the roadway.

Time of Day and Age

In order to analyze data on fatal pedestrian crashes, the time of day was divided into 2-hour increments (see Figure 4). The largest number of crashes occurred between 8 p.m. and 10 p.m. (40 crashes). The smallest number occurred between 12 noon and 2 p.m. (8 crashes). The largest concentration occurred from 4 p.m. to midnight (approximately 60%). An additional 22% occurred between midnight and 8 a.m.

Among pedestrians aged 55 or older, 65% were involved in fatal crashes between 8 a.m. and 8 p.m. These older pedestrians were fatally injured more often during this period of the day than pedestrians in all other age groups.

In contrast, among pedestrians under age 65, 50% to 75% were fatally injured between 4 p.m. and midnight. Only approximately 43% of pedestrians aged 65 or older were involved in crashes during this time, and only 13% of them were involved in crashes after 10 p.m.

Pedestrians aged 16–19 (46%) comprised the age group most involved in crashes between midnight and 8 a.m. Crash involvement during this time was

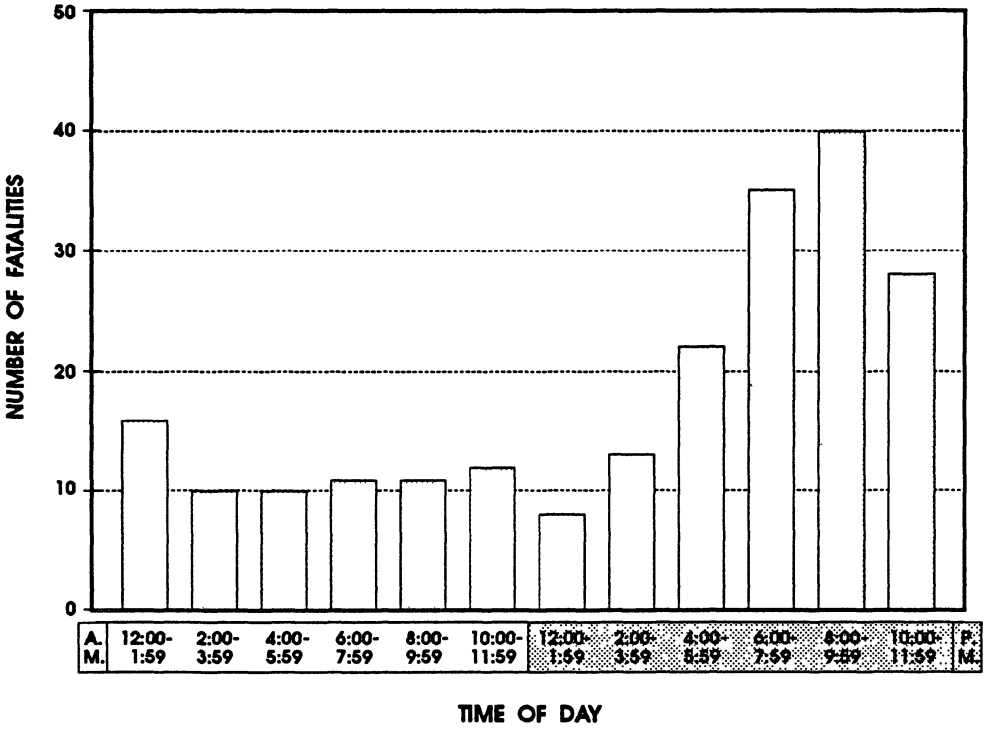

Figure 4. Pedestrian Crashes by Time of Day.

lowest among the 55–64 (3.8% of their fatal crashes) and 75+ age groups (4.3% of their fatal crashes). Of fatally injured pedestrians aged 55 or older, 9.7% were involved in crashes between midnight and 8 a.m. In addition, approximately 11% of pedestrians aged 45–54 and 11% of those under age 16 were involved during this time period.

Day of Week and Time of Day

The largest number of fatal pedestrian crashes (47) occurred on Saturday, and almost as many on Friday—the smallest number (18) occurred on Monday (see Figure 5). Beginning on Monday, the number of crashes per day increased as the week lengthened, until the number sharply declined on Sunday. Although the period from Thursday through Saturday represents only 3 days of the week, approximately 57% of the fatal pedestrian crashes occurred on these days.

As indicated earlier, approximately 60% of all fatal pedestrian crashes occurred between 4 p.m. and midnight. Of the 125 that occurred between 4 p.m. and midnight, 60% occurred from Thursday through Saturday. Overall, at least 44% of the crashes on a given day of the week occurred between 4 p.m. and midnight, with a range from 44.4% on Monday to 65.9% on Friday (see Figure 6). Thus, this time period is overrepresented in fatal crashes.

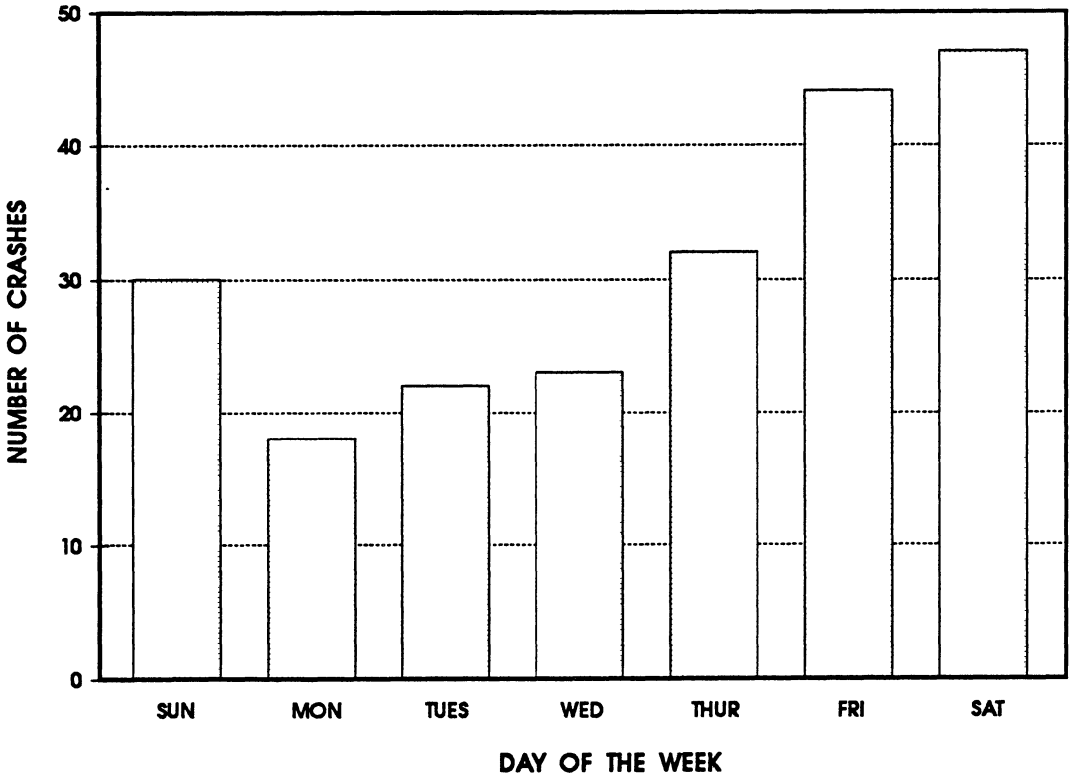

Figure 5. Pedestrian Crashes by Day of Week.

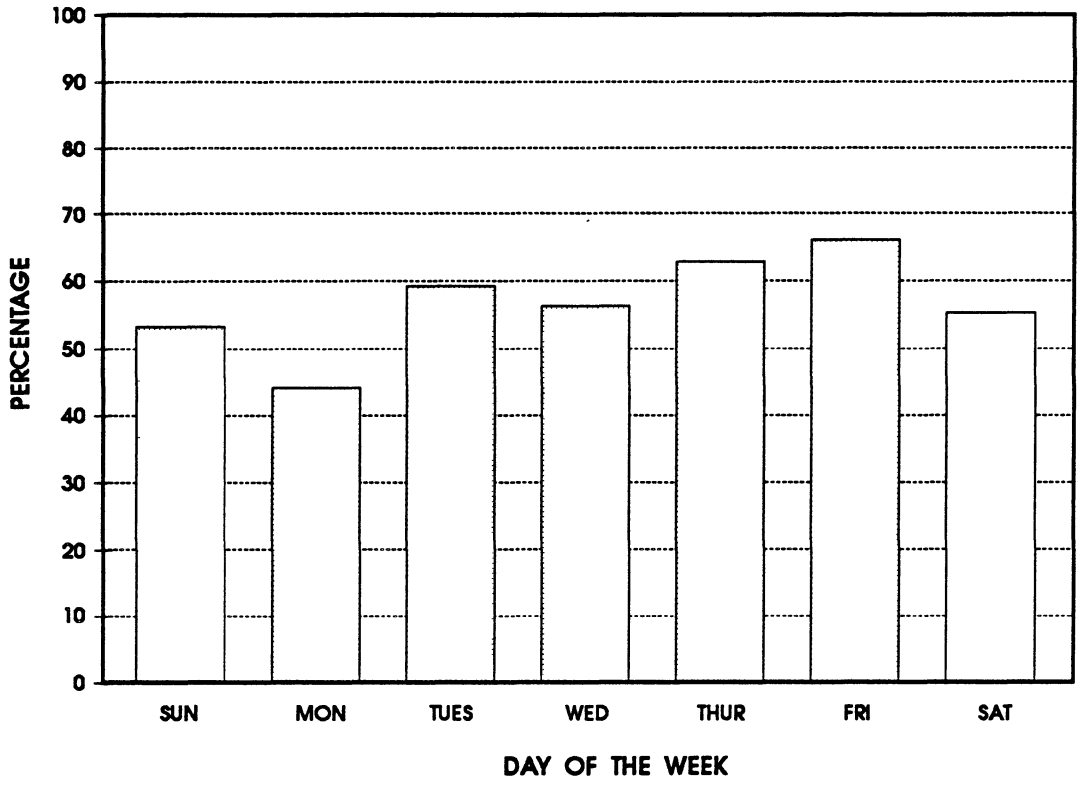

Figure 6. Percentage of Crashes Between 4 p.m and Midnight by Day of Week.

Day of Week and Age

Table 10 provides data by day of week and age. Pedestrians under age 16 were involved in crashes in fairly equal proportions on all days of the week, with the lowest involvement on Saturday. This was not true of other age groups. Sixty-five percent aged 16–54 sustained fatal injuries from Thursday through Saturday. Overinvolvement from Thursday through Saturday began to appear with the 16–19 age group and continued through the 45–54 age group. The proportion of pedestrians in each age group on these days ranged from 52.5% in the 25–34 age group to 78.9% in the 45–54 age group.

Involvement in fatal crashes among pedestrians aged 55 or older was less concentrated on weekends than among other age groups. On Monday, Tuesday, Thursday, and Friday, 70.8% of fatally injured pedestrians aged 55 or older were involved in fatal crashes, whereas only 19.4% were involved on Saturday and Sunday.

Table 10

Number and Percentage of Pedestrians
by Age and Day of Week

AGE GROUP	DAY OF WEEK							TOTAL*
	SUN	MON	TUE	WED	THUR	FRI	SAT	
<5	0	2	3	0	2	1	1	9
	0%	22.2%	33.3%	0%	22.2%	11.1%	11.1%	100.0%
5–7	2	1	0	1	1	1	0	6
	33.3%	16.7%	0%	16.7%	16.7%	16.7%	0%	100.0%
8–10	0	0	0	1	0	3	0	4
	0%	0%	0%	25.0%	0%	75.0%	0%	100.0%
11–15	3	0	1	3	0	0	1	8
	37.5%	0%	12.5%	37.5%	0%	0%	12.5%	100.0%
16–19	2	0	1	0	2	2	6	13
	15.4%	0%	7.7%	0%	15.4%	15.4%	46.2%	100.0%
20–24	5	1	0	2	2	6	8	24
	20.8%	4.2%	0%	8.3%	8.3%	25.0%	33.3%	100.0%
25–34	9	2	3	5	4	6	11	40
	22.2%	5.0%	7.5%	12.5%	10.0%	15.0%	27.5%	100.0%
35–44	1	1	3	2	3	4	7	21
	4.8%	4.8%	14.3%	9.5%	14.3%	19.0%	33.3%	100.0%
45–54	0	0	2	2	2	6	7	19
	0%	0%	10.5%	10.5%	10.5%	31.6%	36.8%	100.0%
55–64	0	4	3	2	8	6	3	26
	0%	15.4%	11.5%	7.7%	30.8%	23.1%	11.5%	100.0%
65–74	3	3	5	2	4	4	2	23
	13.0%	13.0%	21.7%	8.7%	17.4%	17.4%	8.7%	100.0%
75+	5	4	1	3	4	5	1	23
	21.7%	17.4%	4.3%	13.0%	17.4%	21.7%	4.3%	100.0%
TOTAL	30	18	22	23	32	44	47	216
	13.9%	8.3%	10.2%	10.6%	14.8%	20.4%	21.8%	100.0%

*Percentages may not total 100.0% due to rounding.

Month and Season

The largest number of fatal pedestrian crashes (37) occurred in October, and the smallest number (8) in March. The largest proportion of fatal pedestrian crashes occurred in the fall (36.1%) and the winter (25.5%). Data were further analyzed to determine the extent of the problem during the seasons (see Table 11).

The data were first examined according to the time of the day. In the winter, 69.1% of the crashes occurred between 4 p.m. and midnight, and in the fall, only 56.4% of the crashes occurred during this time period. In the spring, 58.8% of the crashes occurred between 4 p.m. and midnight, and in the summer, 46.9% occurred during this time period. Approximately 15% to 18% of crashes in the winter and spring occurred between midnight and 4 p.m., and approximately 20% to 26% of crashes in the summer and fall occurred in this time period (see Table 11).

In the analysis of seasonal variations among age groups (see Table 12), it was found that the fall was particularly dangerous for pedestrians aged 20–34 (45.3% of fatal injuries in this group), 55 or older (38.9% in this group), and under 20 (30% in this group). Among children under age 11, summer, spring, and fall were equally dangerous seasons since approximately 30% of the accidents occurred in each season.

A comparatively high proportion of fatal pedestrian injuries in the 35–54 (35% of fatalities) and 55 or older (26.4% of fatalities) age groups were sustained in the winter. This was also true of pedestrians aged 11–19 (71%).

Table 11

Number and Percentage of Crashes
by Season and Time of Day

SEASON	MIDNIGHT– 7:59 A.M.	8 A.M.– 3:59 P.M.	4 P.M.– MIDNIGHT	TOTAL*
Winter (Dec–Feb)	9 16.4%	8 14.5%	38 69.1%	55 100.0%
Spring (Mar–May)	6 17.6%	8 14.5%	20 58.8%	34 100.0%
Summer (Jun–Aug)	13 26.5%	13 26.5%	23 46.9%	49 100.0%
Fall (Sept–Nov)	19 24.4%	15 19.2%	44 56.4%	78 100.0%
TOTAL*	47	44	125	216

*Percentages may not total 100.0% due to rounding.

Table 12

Number and Percentage of Crashes by Age and Season

AGE GROUP	WINTER (DEC–FEB)	SPRING (MAR–MAY)	SUMMER (JUN–AUG)	FALL (SEPT–NOV)	TOTAL*
<5	0	3	4	2	9
	0%	33.3%	44.4%	22.2%	100.0%
5–7	1	1	2	2	6
	16.7%	16.7%	33.3%	33.3%	100.0%
8–10	1	1	0	2	4
	25.0%	25.0%	0%	50.0%	100.0%
11–15	5	0	0	3	8
	62.5%	0%	0%	37.5%	100.0%
16–19	4	1	5	3	13
	30.8%%	7.7%	38.5%	23.1%	100.0%
20–24	1	4	6	13	24
	4.2%	16.7%	25.0%	54.2%	100.0%
25–34	10	8	6	16	40
	25.0%	20.0%	15.0%	40.0%	100.0%
35–44	6	2	7	6	21
	28.6%	9.5%	33.3%	28.6%	100.0%
45–54	8	3	5	3	19
	42.1%	15.8%%	26.3%	15.8%%	100.0%
55–64	7	5	4	10	26
	26.9%	19.2%	15.4%	38.5%	100.0%
65–74	5	3	7	8	23
	21.8%%	13.0%	30.4%	34.8%%	100.0%
75+	7	3	3	10	23
	30.4%	13.0%	13.0%	43.5%	100.0%
TOTAL	55	34	49	78	216
	25.5%	15.7%	22.7%	36.1%	100.0%

*Percentages may not total 100.0% due to rounding.

Driver Factors

Age

Of the 194 drivers who struck a fatally injured pedestrian and whose ages were reported by the investigating police officer, 102 were young adult drivers, aged 20–34; 46 were middle-aged drivers, aged 35–54; 25 were older drivers, aged 55 or older; and 21 were beginning drivers, aged 16–19 (see Table 13). In the 26 fatal pedestrian crashes where more than one vehicle struck the pedestrian, the information concerns the driver of the vehicle that first struck the pedestrian.

When compared with their distribution among Virginia's licensed urban drivers, it becomes apparent that beginning drivers were overrepresented in fatal pedestrian crashes. Beginning drivers comprised 6.4% of licensed urban drivers yet were involved in 10.8% of the crashes. Young adult drivers were also overrepresented, though not to the extent of beginning drivers.

Older drivers were underrepresented, comprising 21.8% of licensed urban drivers yet involved in only 12.9% of the fatal crashes. Middle-aged drivers were also underrepresented, though not so much as older drivers.

Table 13

Percentage of Licensed Urban Drivers and Number and Percentage of Drivers by Age Whose Vehicle Struck Pedestrian

AGE GROUP	% OF LICENSED URBAN DRIVERS	NO. AND % OF DRIVERS WHO STRUCK PEDESTRIAN
16–19	6.4	21 10.8%
20–34	36.6	102 52.6%
35–54	35.3	46 23.7%
55+	21.8	25 12.9%
TOTAL	100.0*	194 100.0%*

*Percentages do not total 100.0% due to rounding.

Sex

Although male drivers comprised approximately 51% of licensed urban drivers, they were the drivers of 68% of the vehicles that struck fatally injured pedestrians (see Table 14).

Table 14

Percentage of Licensed Urban Drivers and Percentage and Number by Sex Whose Vehicle Struck Pedestrian

SEX OF DRIVER	% OF LICENSED URBAN DRIVERS	NO. AND % OF DRIVERS WHO STRUCK PEDESTRIAN
Male	50.8	132 68.0%
Female	49.2	62 32.0%
TOTAL	100.0	194 100.0%

Age and Time of Day

Among beginning drivers, 71.4% of their fatal pedestrian crashes occurred between 4 p.m. and midnight. Among young adult drivers, 62.7% of their crashes occurred during this time period. Middle-aged drivers were involved in 52.1% of their crashes between 4 p.m. and midnight, and older drivers were involved in 48% of their crashes during this time period (see Table 15).

Table 15

Number and Percentage of Drivers by Age and Time Period When Vehicle Struck Pedestrian

AGE GROUP	12 MIDNIGHT—7:59 A.M.	8 A.M.–3:59 P.M.	4 P.M.–11:59 P.M.	TOTAL
16–19	3 14.3%	3 14.3%	15 71.4%	21 100.0%
20–34	25 24.5%	13 12.8%	64 62.7%	102 100.0%
35–54	9 19.6%	13 28.3%	24 52.1%	46 100.0%
55+	1 4.0%	12 48.0%	12 48.0%	25 100.0%
TOTAL	38 19.6%	41 21.1%	115 59.3%	194 100.0%

Beginning drivers were equally involved in fatal pedestrian crashes during the midnight to 8 a.m. and the 8 a.m. to 4 p.m. time periods—14.3% of their crashes occurred during each of the time periods. Young adult drivers were approximately 2 times as likely to be involved between midnight and 8 a.m. than between 8 a.m. and 4 p.m.—24.5% of their crashes occurred between midnight and 8 a.m., and 12.8% between 8 a.m. and 4 p.m.

Middle-aged drivers were approximately 1.5 times as likely to be involved in a fatal pedestrian crash between 8 a.m. and 4 p.m. than between midnight and 8 a.m.—28.3% of their crashes occurred between 8 a.m. and 4 p.m., and 19.6% between midnight and 8 a.m. Older drivers were equally involved in fatal pedestrian crashes between 8 a.m. and 4 p.m. and between 4 p.m. and midnight (48% each); however, they were less involved between midnight and 8 a.m. than any other group of drivers—only 4% of their crashes occurred during this time period.

Traffic Violations

Information available on violations of traffic laws as reported by the investigating officers indicated that drivers did not violate any traffic laws in 64% of the fatal pedestrian crashes (see Table 16). In crashes where the driver did violate a traffic law, the most frequent driver action was hit-and-run (but this violation could be called an effect rather than the cause of the accident).

Table 16

Driver Actions

DRIVER ACTION	NO.	% OF ALL ACTIONS*	% OF VIOLATIONS
No violation of traffic laws**	125	61.6	——
Hit-and-run	24	11.8	32.9
Driver inattention	16	7.9	21.9
Exceeding speed limit	10	4.9	13.7
Other violations***	28	13.8	31.5
Not stated	13	——	——
TOTAL	216	100.0	

*Excludes "not stated."

**Includes avoiding pedestrian and avoiding another vehicle.

***Includes exceeding safe speed, but not speed limit; cutting in; not having right of way; improper turn; improper passing; other.

Age and Day of Week

Among beginning, young adult, and middle-aged drivers, approximately 57% of the fatal pedestrian crashes for each group occurred from Thursday through Saturday (see Table 17). Involvement from Thursday through Saturday was lowest among older drivers—48% of their crashes occurred on these days.

Table 17
Percentage and Number of Drivers by Age and Day of Week of Crash

AGE GROUP	DAY OF WEEK							TOTAL
	SUN	MON	TUE	WED	THUR	FRI	SAT	
16–19	23.8%	0%	19.0%	0%	4.8%	23.8%	28.6%	100.0%
	5	0	4	0	1	5	6	21
20–24	4.3%	10.6%	12.8%	14.9%	10.6%	21.3%	25.5%	100.0%
	2	5	6	7	5	10	12	47
25–34	18.2%	5.5%	9.1%	9.1%	16.4%	21.8%	20.0%	100.0%
	10	3	5	5	9	12	11	55
35–44	18.5%	7.4%	3.7%	14.8%	18.5%	22.2%	14.8%	100.0%
	5	2	1	4	5	6	4	27
45–54	10.5%	10.5%	5.3%	15.8%	15.8%	21.1%	21.1%	100.0%
	2	2	1	3	3	4	4	19
55–64	25.0%	12.5%	0%	0%	37.5%	12.5%	12.5%	100.0%
	2	1	0	0	3	1	1	8
65–74	10.0%	20.0%	10.0%	20.0%	10.0%	20.0%	10.0%	100.0%
	1	2	1	2	1	2	1	10
75+	0%	42.9%	0%	14.3%	14.3%	28.6%	0%	100.0%
	0	3	0	1	1	2	0	7
TOTAL	13.9%	9.3%	9.3%	11.3%	14.4%	21.7%	20.1%	100.0%
	27	18	18	22	28	42	39	194

*Percentage of row total; may not equal 100.0% due to rounding.

Speed of Vehicle

Approximately 40% of fatal pedestrian crashes occurred when the vehicle that struck the pedestrian was traveling at a speed estimated by the investigating officer to be at least 40 mph (see Table 18). Slightly more than 11% of the vehicles were estimated to be traveling at least 50 mph. Approximately 26% of the vehicles were estimated to be traveling less than 30 mph.

Alcohol Involvement

Approximately 79% of drivers involved in fatal pedestrian crashes had not been drinking (see Table 19). Among the 39 drivers who had been drinking, 46.2% were impaired. However, less than 10% of all drivers involved in fatal pedestrian crashes were impaired.

Table 18

Estimated Speed of Vehicles

VEHICLE SPEED (MPH)	NO.	%*
<10	5	2.8
10–19	11	6.1
20–29	39	21.7
30–39	54	30.0
40–49	46	25.6
50–54	9	5.0
55+	16	8.9
Not stated	33	——
TOTAL	213	100.0

*Excludes "not stated."

Table 19

Alcohol Involvement of Drivers

DRIVER ALCOHOL INVOLVEMENT	NO.	%*
Had not been drinking	149	79.3
Drinking—impaired	18	9.6
Drinking—not impaired or unknown whether impaired	21	11.2
Not stated	25	——
TOTAL	213	100.0

*Excludes "not stated"; does not equal 100.0% due to rounding.

Roadway and Environmental Factors

Weather and Roadway Surface Conditions

According to information contained in investigating officers' reports, weather conditions were clear at the time of 65.3% of the crashes and the roadway surface was dry at the time of 81.5% of the crashes (see Tables 20 and 21). Data obtained from the state climatologist indicate that weather conditions were clear approximately 40% of the time in Virginia's urban areas during the study period.

According to the investigating officers' reports, weather conditions were rainy at the time of 13.9% of the crashes and the roadway surface was wet at the time of 17.6% of the crashes. Climatological data indicate that weather conditions were rainy approximately 31% of the time in Virginia's urban areas during the study period.

Table 20

Weather at Time of Crash and During Study Period

WEATHER CONDITION	TIME OF CRASH NO.	%	STUDY PERIOD NO.	%
Clear	141	65.3	435	39.7
Cloudy	37	17.1	285	26.0
Rainy	30	13.9	340	31.1
Other*	8	3.7	35	3.2
TOTAL	216	100.0	1,095	100.0

*Includes fog, mist, ice, snow.

Table 21

Roadway Surface Conditions at Time of Crash

ROADWAY CONDITION	NO.	%
Dry	176	81.5
Wet	38	17.6
Other*	2	0.9
TOTAL	216	100.0

*Includes snow and ice.

Visibility and Light Conditions

At the time of 78% of the crashes, driver visibility was not obscured by roadway or environmental factors (see Table 22). The driver's sight was obscured by rain, snow, etc. on the windshield or by other roadway and environmental factors

Table 22

Driver Visibility at Time of Crash

DRIVER VISIBILITY	NO.	%*
Not obscured	149	78.0
Rain, snow, etc. on windshield	17	8.9
Obscured by moving vehicles	9	4.7
Other**	16	8.4
Not stated	22	—
TOTAL	213	100.0

*Excludes "not stated."
**Trees, crops, embankments, sun or headlight glare, load on vehicle, parked vehicles, and other.

Table 23

Light Conditions at Time of Crash

LIGHT CONDITIONS	NO.	%
Darkness—roadway lighted	83	38.6
Darkness—roadway not lighted	60	27.9
Daylight	59	27.4
Other*	13	6.0
Not stated	1	—
TOTAL	216	100.0

*Dusk and dawn.

(such as a parked vehicle or sun glare) in only 17.3% of the crashes. However, these factors were not determined to be major contributors to fatal pedestrian crashes.

Approximately 28% of the crashes occurred after dark on an unlighted roadway (see Table 23). An additional 38.6% occurred after dark on a lighted roadway. Approximately 27.4% of the crashes occurred during daylight.

Posted Speed Limit, Roadway Alignment, and Intersections

The largest proportion of crashes (25.1%) occurred at a site where the posted speed limit was 35 mph; however, almost as many occurred where the posted speed limit was 45 mph or 25 mph (see Table 24). Of all the crashes, 54.9% occurred where the posted speed limit was 35 mph or less. Further, 74.1% of them occurred on a straight, level roadway and an additional 13.9% on a straight grade (see Table 25).

Table 24

Posted Speed Limits at Crash Sites

POSTED SPEED LIMIT	NO.	%*
25	47	21.9
30	17	7.9
35	54	25.1
40	9	4.2
45	49	22.8
50	4	1.9
55	35	16.3
Not stated	1	—
TOTAL	216	100.0

*Excludes "not stated."

Table 25

Alignment of Roadway at Crash Site

ROADWAY ALIGNMENT	NO.	%
Straight—level	160	74.1
Grade—straight	30	13.9
Curve—level	13	6.0
Other*	13	6.0
TOTAL	216	100.0

*Includes grade—curve; hillcrest—straight; dip—straight.

Table 26

Intersection-Related Crashes by Type of Intersection

INTERSECTION TYPE	NO.	%*
Crossing	57	53.8
T	35	33.0
Offset	9	8.5
Branch	3	2.8
Interchange	2	1.9
Not intersection related *or* not stated	110	——
TOTAL	216	100.0

*Excludes "not stated."

Fatal pedestrian crashes are known to have occurred within 150 feet of an intersection in 106 of the 216 fatal pedestrian crashes between 1985 and 1987. Of these, 53.8% occurred at a crossing and 33% at a "T" (see Table 26).

Vehicle Factors

In 75.1% of fatal pedestrian crashes, a passenger car struck the pedestrian. A pickup or passenger truck was involved in approximately 11% of the crashes. According to data obtained from the Virginia Department of Motor Vehicles, the proportion of vehicles of these types that were registered in urban areas was similar to the proportion involved in fatal pedestrian crashes (see Table 27). Vehicles were proceeding straight ahead at the time of approximately 87% of the crashes (see Table 28).

Table 27

Number and Percentage of Striking Vehicles by Type and Number and Percentage of Registered Vehicles (1986) in Urban Areas by Type

	STRUCK PEDESTRIAN		REGISTERED (IN MILLIONS)	
VEHICLE TYPE	NO.	%*	NO.	%
Passenger car	148	75.1	2.2	85.1**
Pickup or passenger truck	21	10.7	—	—
Van	10	5.1	0.1	5.1
Other***	18	9.1	0.3	9.8
Not stated	16	—	—	—
TOTAL	213	100.0	2.6	100.0

*Excludes "not stated."

**Passenger cars and pickups or passenger trucks were included in the "passenger car" type in data obtained from DMV.

***Includes straight truck, tractor-trailer, bicycle, motorcycle, school bus, city transit bus, and multipurpose vehicles.

Table 28

Vehicle Maneuver When Pedestrian Struck

VEHICLE MANEUVER	NO.	%*
Going straight	178	87.3
Ran off road to right	8	3.9
Other**	18	8.8
Not stated	9	—
TOTAL	213	100.0

*Excludes "not stated."

**Includes making left or right turn, slowing or stopping, parking, passing, ran off road to left, started from parked position, stopped in traffic lane, changing lanes, and other.

CONCLUSIONS

Because there were no data available on pedestrian travel patterns in Virginia's urban areas, the conclusions are somewhat tentative. In many instances, data on exposure levels and associated pedestrian trip patterns in Virginia's urban areas would help make the conclusions more definitive. For example, overrepresentation and underrepresentation in fatal pedestrian crashes among age groups were

determined through a comparison of the percentage of the total fatal pedestrian crashes for each age group to the percentage of the total urban population represented by each age group. A more precise method would allow for a comparison of the percentage of pedestrian trips made by a given age group to the total number of fatally injured pedestrians in the age group.

Conclusions that may tentatively be drawn from this study are as follows:

1. *Negligent pedestrian behavior contributes to the occurrence of fatal pedestrian crashes more so than factors associated with the driver of the vehicle that struck the pedestrian, the roadway or environment at the crash site, or the vehicle itself.* The influence of alcohol and/or other drugs on the pedestrian and pedestrian inattention or error contributed to the majority of fatal pedestrian crashes.

2. *Alcohol and/or other drug use is not a major contributing factor in crashes involving pedestrians under age 20 or aged 55 or older.* No pedestrian under age 20 and only 22% of those aged 55 or older had been drinking, whereas 60% of the pedestrians aged 20–64 had been drinking.

3. *The elderly are more likely than younger persons to be fatally injured rather than nonfatally injured as a result of being struck by a vehicle.* Compared to their distribution among the urban population, pedestrians age 55 or older were overrepresented in fatal crashes and pedestrians under age 16 were underrepresented. The fatality rate was the lowest among children under age 16, remained steady through age 54, steadily increased through age 74, and reached its peak at age 75 or older (2.0 per 10,000 population). More recently, greater focus has been placed on the special needs of elderly citizens by a variety of public and private organizations. With the cooperation of transportation officials, urban planners, and advocates of pedestrian safety, a reduction in the pedestrian fatality rate among the elderly should be an attainable goal.

4. *Virginia's child safety programs may be having a positive effect in preventing serious injury among young children.* The fatality rate is lowest among children under age 16 (0.3 per 10,000 population).

5. *The higher a pedestrian's BAC level, the more likely a pedestrian is to be involved in a fatal crash.* In this study, 41% of the fatally injured pedestrians had been drinking, and of these, 91% had a BAC above the legal limit for intoxication (0.10%). Further, approximately 58% of the pedestrians who had been drinking had a BAC of 0.20% or higher.

6. *The end of the week and weekends are high risk periods for involvement in a fatal pedestrian crash, particularly from late afternoon to late evening. However, elderly pedestrians are less at risk during this period than are pedestrians in other age groups.* Nearly 60% of the fatal pedestrian crashes occurred from Thursday through Saturday. On these days, 61% of the crashes occurred between 4 p.m. and midnight.

7. *The risk of fatal pedestrian crashes is greater during darkness. However, there are age-related differences in the level of exposure to potential pedestrian risks*

throughout the day. Approximately 60% of fatal pedestrian crashes occurred between 4 p.m. and midnight, and an additional 22% occurred between midnight and 8 a.m. However, the involvement of young children and the elderly was comparatively small during these time periods. The majority (67%) of fatally injured pedestrians age 55 or older were involved in crashes between 8 a.m. and 8 p.m., and the majority (56%) of fatally injured children under age 16 were involved in crashes between 4 p.m. and 8 p.m. Typically, young children are in school and/or under adult supervision in the daylight hours and participate in recreational activities that are less supervised during the period immediately after school. This period of the day is also the time when many drivers return home from work or school. Thus, this may be the time of day when young children are most vulnerable.

8. *The elderly encounter greater difficulty than younger persons in negotiating potentially complex situations, such as crossing the street in densely populated urban areas*. The majority (55%) of fatally injured pedestrians were crossing the street when struck by a vehicle. Pedestrians age 55 and older were more likely than younger pedestrians to be crossing the street when struck. They were approximately 7 times as likely to be struck while crossing the street than when walking on or along the roadway (the second most frequent pedestrian action at the time of the fatal crash).

9. *Males engage in risk-taking behavior to a greater degree than females*. Compared with their distribution in the general population, male pedestrians were overrepresented in fatal pedestrian crashes, both as pedestrians and as drivers of vehicles that struck pedestrians. Male pedestrians had a higher fatality rate than female pedestrians, were 2 times as likely to have been drinking, and were about 3 times as likely to be crossing the street when struck. In addition, although males made up approximately 51% of licensed drivers, they were involved in 68% of the fatal pedestrian crashes.

10. *Reduced visibility during times of comparatively heavy pedestrian and vehicle volumes and during the seasons of the year when less daylight is available plays a part in the occurrence of fatal pedestrian crashes. In addition, poor visibility plays a greater role in the occurrence of fatal pedestrian crashes than do weather-related or traffic engineering factors*. The largest proportion of fatal pedestrian crashes occurred in the fall (36%) and the winter (26%). Of the crashes that occurred in the winter, 69% occurred between 4 p.m. and midnight; in the fall, 56% occurred during this time period. Comparatively large proportions of preteens and teenagers (71%) and persons age 55 or older (65%) were fatally injured in the fall or winter. Nearly 65% of fatal pedestrian crashes occurred during clear weather, and approximately 67% during darkness. There were no roadway or environmental conditions that obstructed driver visibility in 78% of the crashes.

11. *Driver involvement in fatal pedestrian crashes decreases as the age of the driver increases*.

12. *Statistics for Virginia are similar to those for other states that have studied their urban fatal pedestrian crash problem—the exception is Virginia's lower fatality rate among young children*.

RECOMMENDATIONS

1. *Study and document the pedestrian behavior patterns of Virginia's urban population for the purposes of developing and implementing effective pedestrian safety measures.* In the absence of exposure data on the behaviors of pedestrians in Virginia's urban population, it is difficult to determine the extent to which various pedestrian groups are underrepresented or overrepresented in fatal pedestrian crashes. For example, although this study found that the younger age groups were underrepresented when compared with their distribution among the urban population, no data were available on the proportion of walking trips made by persons in these age groups. This precludes drawing inferences from data that would permit comparisons among age groups based on patterns of pedestrian behavior.

In order to develop proposals for effective management of pedestrian flow and safety, it is essential that the most current information concerning pedestrian volumes, walking distances, and travel patterns by time of day, trip purpose, season of year, etc., as well as corresponding vehicular volume data, be carefully considered. In the absence of such information, it is difficult to make inferences about the true factors that contribute to the present level of fatal pedestrian crashes.

2. *Further investigate the relationships among pedestrian behaviors and among driver behaviors in urban areas, with emphasis on determining differences among age groups and between sexes.* This study found, for example, that younger male drivers, based on their distribution among the urban driver population, were overrepresented in fatal pedestrian crashes, especially at night and on weekends. It was suggested that younger male drivers are more likely than other drivers to drive on weekends and at night.

With the current emphasis on walking as a healthy, recreational activity, there is likely to be an increased volume of pedestrians walking during evenings and on weekends. With a high pedestrian volume and a high vehicle volume during evenings and on weekends, the potential for pedestrian crashes is increased. Valid data on driver and pedestrian behaviors and volumes will be required in order to develop and implement effective pedestrian safety measures.

3. *Explore the feasibility of developing an ongoing program directed toward preventive measures that can be taken by pedestrians and drivers to prevent fatal injuries in urban areas.* The majority of fatal pedestrian crashes may be traced to risk-taking behavior by the pedestrian. Many persons assume they can walk with minimal risks. Although this may be true under the most ideal of conditions, this report highlights several environmental and individual phenomena that may be associated with the likelihood of fatal injury to the pedestrian. Drivers and pedestrians should be well informed about hazards to the pedestrian when conditions exist that could result in a pedestrian crash.

Balanced preventive programs should include training drivers to make adjustments for the fact that many pedestrians are unlikely to react quickly and appropriately to an approaching vehicle. In addition, public information campaigns

should emphasize the risks to pedestrians posed by excessive alcohol consumption; weekend pedestrian activities; hazards that result from poor visibility, including evening, fall, and winter light conditions; and, for the elderly, the potentially complex action of crossing the street.

4. *Explore traffic engineering enhancements that might improve pedestrian safety*. Although traffic engineering factors were not identified as major contributors to fatal pedestrian crashes, attention should be paid to engineering strategies that effectively separate pedestrians and vehicles. This recommendation implies that pedestrian behavior may be extremely difficult to change. Moreover, some persons are fatally injured in crashes that may not be preventable by measures aimed solely at pedestrians (e.g, collisions that involve failures and inadequacies of vehicles or drivers; environmental deficiencies such as inadequate sight lines, poor lighting, and lack of sidewalks). Traditional efforts to prevent pedestrians, particularly children, from being killed or injured have focused on pedestrian behavior; comparatively little attention has been paid to strategies that effectively separate them from vehicles.

5. *Through research, determine the elements of effective child pedestrian safety programs in Virginia's urban areas and incorporate them into programs that focus on pedestrian safety among the elderly*. One finding in this research that contradicts the findings of other research on fatal pedestrian crashes is the low fatality rate among young children when compared with the rate among elderly pedestrians. Other research generally concludes that the pedestrian fatality problem is equally serious for these groups.

In recent years, Virginia has been very active in promoting child safety through a variety of state and local programs. One of the components of the programs emphasizes pedestrian safety. Although this research did not address evaluative findings on the effectiveness of the programs, it was concluded that they may be having a positive effect on the prevention of child injuries. If, in fact, the programs for children are effective in reducing injuries, there are probably elements in the programs that can be modified and applied to similar programs for the elderly. Should this activity be undertaken, a reduction in pedestrian fatality rates among Virginia's elderly population might be realized.

REFERENCES

American Automobile Association. (1970). Special survey on alcohol testing and pedestrian accidents. *Pedestrian Safety Report, 1*(2), 1–4.

American Automobile Association. (1984). *Special report on pedestrian deaths and injuries for ages 0 through 29.* Falls Church, VA: Author.

American Automobile Association. Tidewater Automobile Association. (1987). *Facts about pedestrians.* Norfolk, VA: Author.

Ashton, S. J.; Pedder, J. B.; and MacKay, G. M. (1977). *Pedestrian injuries and the car exterior* (Report No. SAE-770092). Birmingham, England: University of Birmingham.

Blomberg, R. D.; Preusser, D. F.; Hale, A.; & Ulmer, R. G. (1979). *A comparison of alcohol involvement in pedestrians and pedestrian casualties.* Springfield, VA: National Technical Information Service.

Burton, L. (1968). *Vulnerable children.* New York: Shocken.

Bush, R. J. (1985). *Statewide pedestrian study. Phase III: Correlation and evaluation of pedestrian accident data.* Washington, DC: Maryland Department of Transportation and Federal Highway Administration.

Ehrlich, P.; Farina, A.; Pavlinski, L.; & Tarrants, W. E. (1982). *Effectiveness and efficiencies in pedestrian safety: Evaluation summary report.* Springfield, VA: National Technical Information Service.

Farmer, P. J. (1968). Let's shed some light on pedestrian and cyclist safety: An approach to the problem. *Highway Safety, 7,* 51–56.

Fell, J. C., & Toth, G. R. (1981). *Pedestrian accidents: A state-of-the-art: 1970–1980.* (DOT Report No. HS-806-270). Washington, DC: National Center for Statistics and Analysis, National Highway Traffic Safety Administration.

Husband, P., & Hinton, P. E. (1972). Families of children with repeated accidents. *Archives of Disabled Children, 47,* 396–400.

Illinois Department of Public Works and Buildings. (1966). *Auto-pedestrian traffic accidents in Illinois.* Springfield: Author.

Itoh, M. (1979). *Analysis of pedestrian accidents taken from a road traffic accident investigation.* Paper presented at the Seventh International Technical Conference on Experimental Safety Vehicles, Washington, DC.

Knoblauch, R. L.; Moore, W., Jr.; & Schmitz, P. R. (1978). *Pedestrian accidents occurring on freeways: An investigation of causative factors, data collection and analysis,* Vol. 2 (Report No. FHWA-RD-78-170). Washington, DC: U.S. Department of Transportation.

Kraay, J. H. (1976). *Pedestrians, two-wheelers, and road safety: A statistical comparison of pedestrian, cyclist and moped-rider road traffic fatalities in The Netherlands from 1968 to 1972.* Voorburg, The Netherlands: Institute for Road Safety Research.

Krall, V. (1953). Personality characteristics of accident-repeating children. *Journal of Abnormal Social Psychology, 48,* 99–107.

Linder, E. L; Mullen, C. B.; & Griffin, L. I. (1975). *Statewide system for analysis of pedestrian and bicycle accidents.* Chapel Hill: University of North Carolina Highway Safety Research Center.

Manheimer, D. I., & Mellinger, G. D. (1967). Personality characteristics of the child accident repeater. *Child Development, 38,* 491–513.

Marsden, W. E. (1972). *Alcohol and pedestrian fatalities: A study of fatal pedestrian collisions in San Diego County.* Chicago: National Safety Council.

National Safety Council. (1988). Policy pedestrian protection. *Traffic Safety,* January/February, 20–23.

Pfefer, R. C.; Sorton, A.; Fegan, J.; & Rosenbaum, M. J. (1982). Pedestrian ways. In Federal Highway Administration (ed.), *Safety research related to traffic control and roadway elements* (Chapter 16). Washington, DC: U.S. Department of Transportation.

Preusser, D. F. (1988). Training walkers to watch. *Traffic Safety,* January/February, 12–15.

Robertson, H. D.; Berger, W. G.; & Pain, R. F. (1977). *Urban intersection improvements for pedestrian safety* (Report No. FHWA-RD-77-143). Washington, DC: U.S. Department of Transportation.

Salk, K. (1973). Emotional factors in pediatric practice. *Pediatric Annals, 4,* 66–71.

Senevirante, P. N., & Fraser, P. (1987). *Issues related to planning for pedestrian needs in central business districts* (Report No. TRR 1141, pp. 7–14). Washington, DC: Transportation Research Board.

Senevirante, P. N., & Shuster, E. M. (1989). *Characteristics of pedestrian accidents in Montreal central business district.* Paper presented at the 68th Annual Meeting of the Transportation Research Board, Washington, DC.

Simpson, H. M., & Warren, R. A. (1979). Characteristics of fatally-injured impaired pedestrians. *Canadian Society of Forensic Science Journal, 12*(1), 31–40.

Snyder, M. B. (1972). Traffic engineering for pedestrian safety: Some new data and solutions. *Highway Research Record, 406,* 21–27.

Tell, J. C., & Hazzard, B. G. (1985). *The role of alcohol involvement in fatal pedestrian collisions.* Arlington Heights, IL: American Association for Automotive Medicine.

Tsongos, N. G. (1984). *Pedestrian accident characteristics and injury patterns.* Paper presented at the Second International Congress of Traffic Medicine in Yugoslavia, Dubrovnik.

Viney, L. (1971). Accident proneness: Some psychological research. *Medical Journal of Australia, 2,* 916–918.

Wilson, D. G., & Grayson, G. B. (1980). *Age-related differences in the road crossing behavior of adult pedestrians* (Report No. TRR-LR-933). Springfield, VA: National Technical Information Service.

Zaidel, D. M., & Hocherman, I. (1987). *Safety of pedestrian crossings at signalized intersections* (Report No. TRR 1141, pp. 1–6). Washington, DC: Transportation Research Board.

Zegeer, C. V., & Deen, R. C. (1976). Pedestrian accidents in Kentucky. *Highway Safety, 20,* 26–28.

Zegeer, C. V., & Zegeer, S. F. (1988). *Pedestrian and traffic control measures.* Washington, DC: Transportation Research Board.

APPENDIX

List of Virginia's Urban Jurisdictions

CITIES	COUNTIES
Alexandria	Arlington
Bedford	Chesterfield
Bristol	Fairfax
Buena Vista	Henrico
Charlottesville	Loudoun
Chesapeake	Montgomery
Clifton Forge	Prince William
Colonial Heights	Roanoke
Covington	Warren
Danville	York
Fairfax	
Emporia	
Falls Church	
Franklin	
Fredericksburg	
Galax	
Hampton	
Harrisonburg	
Hopewell	
Lexington	
Lynchburg	
Manassas	
Manassas Park	
Martinsville	
Newport News	
Norfolk	
Norton	
Petersburg	
Poquoson	
Portsmouth	
Radford	
Richmond	
Roanoke	
Salem	
South Boston	
Staunton	
Suffolk	
Virginia Beach	
Waynesboro	
Williamsburg	
Winchester	