form, and for that help the author is indebted. Thanks are also due to the Map Library of the Department of the Environment, from which the numerous maps needed for the study were obtained. The field surveys were carried out by a number of drivers and navigators, who also assisted in the tedious work of extracting the data and preparing it for analysis. In particular, the author would like to thank L. Frost, D. Warriner, J. Davies, M. Wagrel, and A. Dunford for their contributions. The regional and national analyses were carried out by J. Goldschmidt, M. Iqbal, and P. Wood.

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Pedestrian Characteristics and Exposure Measures

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ABSTRACT

The objectives of this research were to identify specific pedestrian trip-making characteristics, develop pedestrian exposure measures, and examine these trip-making characteristics and exposure measures relative to accident information in order to determine the relative hazardousness of various pedestrian characteristics and behaviors. A large-scale field study was conducted in five standard metropolitan statistical areas (SMSAs). A total of 12,528 person-hr were devoted to observing vehicles and pedestrians at a stratified random sample of locations in five SMSAs. Volume and activity data were recorded for 612,395 vehicles and 60,906 pedestrians. In addition, 20,147 pedestrians were coded by demographic characteristics and behavior. A total of 1,357 sites were measured, photographed, and described. Data on pedestrian trip-making characteristics and behavior are presented: who walks, where they walk, how they walk (or run), and when they walk. Pedestrian exposure is described in terms of the number of pedestrian-vehicle (PV) interactions. Exposure data are presented in terms of various pedestrian and site characteristics. Relative hazardousness was determined by comparing the exposure data with pedestrian accident data. The relative hazard associated with various site characteristics, pedestrian and vehicle characteristics, and pedestrian and vehicle actions is described.

Nearly one of every five traffic fatalities is a pedestrian. Pedestrian accidents account for 5 percent of all traffic accidents. The nature and extent of the pedestrian accident problem has been examined in many accident studies (1-3). However, for accident data to be meaningful, they should be compared with the experience of the nonaccident population, or the population at risk. This information on the population at risk is called exposure data. With the exception of some British and Australian studies (4-7), little is known about the nature of pedestrian exposure. This project reports on what pedestrians are doing when they are walking from place to place on public rights-of-way.

The results of an FHWA project on pedestrian risk exposure measures are described. The project had three major goals:

1. To identify pedestrian trip-making characteristics and behavior,
2. To determine characteristics of pedestrian exposure, and
3. To determine relative hazardousness of pedestrian behaviors, activities, and various situational factors.

RESEARCH PROCEDURES

A goal of the project was to develop a defensible national estimate of pedestrian behavior. To do this, it was necessary to observe pedestrians at a sample of locations that would allow the observed behavior to be developed into a national estimate. A series of random and stratified-random procedures was used to select the data-collection areas and the data-collection sites within those areas.

Site Selection

City selection was based on NHTSA's National Accident Sampling System (NASS), which provided a statistically sound sample with a properly developed weighting system. The NASS system consists of 10 strata of approximately equal size. Each stratum contains about 10 percent of the nation's population. They range in size from stratum 1, which contains large cities, to stratum 10, which contains small villages and towns. To concentrate efforts on the more densely populated areas of the country, data-collection areas were selected from the first four strata. The five areas selected included New York City; St. Louis, Missouri; Seattle, Washington; St. Petersburg, Florida; and Prince Georges and Charles counties in Maryland. These areas represent 40 percent of the nation's population and include urban as well as relatively densely populated suburban and rural areas.

The site selection procedure had to have the capability to allow the projection of activity within the entire city and allow comparability among the data collected in each of the various cities. Because of the lack of comparability in zoning maps, land use maps, and street inventories, a site inventory procedure was developed.

A randomly selected 5 percent sample of the area of each city was inventoried to catalog all the intersection and midblock sections. Each intersection and each midblock section in the sample was visited and defined in terms of land use (commercial, residential, etc.), number of traffic lanes, signalization, and total length (midblock sections only). The sites inventoried were divided into categories based on these descriptors. A stratified random sample of 99 locations was selected from the sites inventoried in each of the study areas. Thus, a stratified random sample of 495 sites in five randomly selected cities was selected.

Data Collection

Three types of data were collected and analyzed: pedestrian and vehicle exposure data, site-characteristics data, and accident data. The exposure data were collected to determine the number and type of people and vehicles that pass through the site and to specifically identify what they are doing. Four different types of exposure data were collected: pedestrian volume and action data, vehicle volume and action data, pedestrian activity sample, and counts of special types.

The pedestrian volume and action data included the number of pedestrians crossing within a crosswalk, crossing within 50 ft of a crosswalk, crossing midblock, and crossing the intersection diagonally. This information was recorded for more than 60,000 pedestrians observed at the sites.

The vehicle volume and action data included the total number of vehicles; the number of vehicles turning right, turning left, and making a right turn on a red signal; the number of vehicles encountering pedestrians; the type of vehicle; and the number of specific vehicle actions. This information was recorded for more than 612,000 vehicles passing through the sites.

The pedestrian activity sampling data involved specific information on a randomly selected subset of all the pedestrians observed. Each pedestrian selected was tracked as he or she passed through the site. The following information was recorded: age, sex, accompaniment (alone or with others), location, distance walked, signal compliance, mode (walking or running), and interactions with vehicles either passing straight through or turning at the intersection. This information was coded for more than 20,000 pedestrians.

Additional tallies were kept of certain types passing through the site. These special counts kept track of the number of bicyclists, joggers, skaters, blind pedestrians, and transportation-handicapped pedestrians.

The exposure data describe what pedestrians and vehicles are doing. The site characteristics describe where they are doing it. The following site factors were recorded: land use, roadway functional classification, parking characteristics, roadway surface, shoulder surface, pavement markings, crosswalks, street lighting, signalization, channelization, signing, type of intersection, and pedestrian accommodations. This information was recorded at all 495 exposure sites from 7:00 a.m. to 11:00 p.m. on a weekday. In addition, one-third of the sites (some from each site type) were covered from 7:00 a.m. to 11:00 p.m. on a Saturday and a Sunday.

The exposure data and the site-characteristic data give a picture of when, where, and how people are exposed to traffic. To determine which of these activities or characteristics are dangerous, comparable information was needed from pedestrians involved in accidents. A sample of approximately 200 pedestrian accident reports was obtained from each of the five study jurisdictions. The accidents were selected to correspond to the same time of the day and same general time of the year as the exposure data. The following information was coded from each police report: time of day, pedestrian age and sex, light condition, vehicle type, pedestrian location (crosswalk or midblock), signal compliance, pedestrian accompaniment, vehicle type and action, and accident type. In addition, more detailed information on the characteristics of the accident sites was needed. Each of the 762 accident sites was visited and the previously described site factors were recorded.

Sample Weighting

A series of random and stratified-random selection techniques was used to select the data-collection sites and to collect the data. In order to develop national estimates of pedestrian behavior from the data that were collected, a series of sample weighting procedures was applied. Weighting procedures were developed to project the data-collection sessions to produce hourly vehicle and pedestrian volumes, project hourly volumes to produce a full week of pedestrian and vehicle activity, project the stratified sample to locations to represent an entire city, correct for the deliberate oversampling of central business districts (CBDs), project the city totals to represent their NASS strata, and project the NASS strata totals to represent the study nation. In this project, the nation is the more densely populated 40 percent of the country. A total of 12,528 hr of pedestrian and vehicle activity was observed and recorded. The weighting procedures were used to project the pedestrians and vehicles observed to represent the nation.

RESULTS

Pedestrian Characteristics

A great deal of descriptive information on pedestrian characteristics was collected. By conducting tracking studies, information was collected on pedestrian sex, pedestrian age, estimated age, mode (walking or running), crossing location, accompaniment, signal observance, and other factors that provide a useful basis for describing activity and behavior of the American pedestrian. The pedestrian characteristics were analyzed under four major headings:

1. Who walks (age and sex of the observed pedestrian population);
2. Where pedestrians walk (pedestrian activity in terms of adjoining land use and crossing behavior);
3. When pedestrians walk (pedestrian activity in terms of time of day, day of week, and crossing location; age and sex differences also);
4. What pedestrians do [pedestrian activity in terms of crossing behavior, time spent in the roadway, mode (walking or running), accompaniment (alone or with others), signal compliance, and gap acceptance].

Two examples of the pedestrian characteristics are presented. Figure 1 shows the age and sex distribution of the national walking population. Children under 14 account for 16.5 percent of the pedestrians observed, yet they constitute 21.1 percent of the population of the study locations. Nearly 60 percent of the pedestrians observed were male, a finding that was consistent across all age groups except for those 60 and over. In contrast, slightly less than half of the population of the study locations was male.

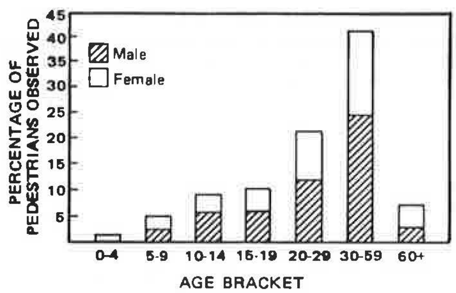

FIGURE 1 Pedestrian characteristics by age and sex.

Figure 2 shows pedestrian activity by hour of day for males and females. The relatively high level of pedestrian activity across the entire data-collection day (7:00 a.m. to 11:00 p.m.) was somewhat surprising. It was expected that the curves would be trimodal with a.m., noon, and p.m. pedestrian activity peaks. The curves for female and male pedestrians show distinctive noon peaks; in addition, the curves indicate that more males walk in the evening hours.

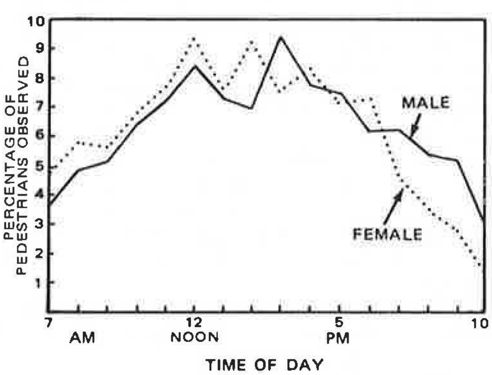

FIGURE 2 Pedestrian activity by sex by hour of the day.

Pedestrian Exposure Measures

Pedestrian exposure measures were developed by combining the pedestrian and vehicle activity information. The exposure measure used was a refinement of Cameron's (4) concept of pedestrian-vehicle (PV) interaction. In addition to Cameron's constraint that the pedestrians and vehicles need to be counted within a relatively similar time frame and that the periods of observation be short, it was required that the paths of particular vehicles and pedestrians cross each other in order for those vehicles and pedestrians to enter the exposure count. The pedestrian and vehicle actions and locations had to be organized to resemble potential accident encounters. A total of six different types of exposure measures was collected and analyzed:

1. Pedestrian crossing midblock, vehicle proceeding straight ahead;
2. Pedestrian crossing at intersection, vehicle proceeding straight through the intersection;
3. Pedestrian crossing at intersection, vehicle concluding either a right or left turn (two types);
4. Pedestrian crossing at intersection, vehicle initiating either a right or left turn (two types).

Each of these exposure measures was considered relative to adjoining land use, day of the week, NASS strata, time of day, number of traffic lanes, roadway functional classification, block length, intersection configuration, and special activity magnets (schools, parks, etc.).

Two examples of the pedestrian exposure data are presented. Figure 3 shows the total of all six pedestrian exposure types categorized by land use. The

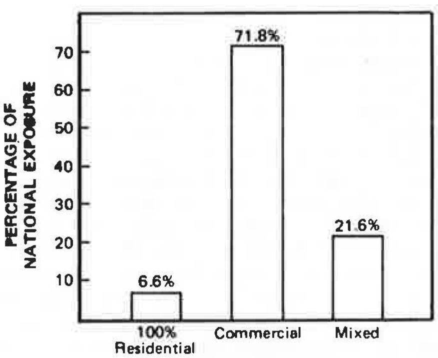

FIGURE 3 Pedestrian exposure by type of land use.

majority of the PV exposure occurs in commercial (71.8 percent) and mixed residential (21.6 percent) areas. Only 6.6 percent of the exposure occurs in areas classified as 100 percent residential. Of particular interest is the discovery that more than 55 percent of the total sites were classified as 100 percent residential and only 17 percent were classified as commercial. More than 70 percent of the pedestrian exposure occurs at 17 percent of the sites. Figure 4 shows the distribution of pedestrian exposure by roadway classification. More than 60 percent of the total pedestrian exposure occurs on collector-distributor roadways; 24 percent is on local streets. Not shown is the finding that the percentage of midblock crossing contributing to the total exposure decreases across roadway type; there is more midblock crossing on local streets than on collector-distributors and even less on major arte-

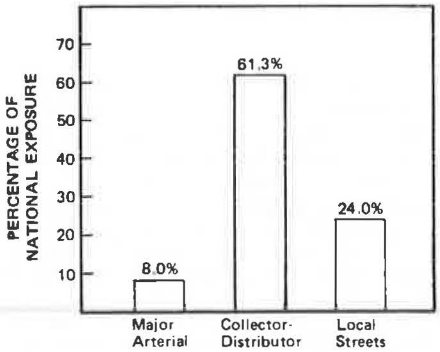

FIGURE 4 Pedestrian exposure by roadway classification.

rials. Thirty percent of the local street pedestrian exposure occurs midblock, whereas 23 percent of exposure on major arterials is at midblock locations.

Relative Hazard

In previous sections pedestrian exposure measures and pedestrian trip-making characteristics have been discussed. The relationship between these pedestrian exposure and pedestrian trip-making characteristics and pedestrian accidents is addressed here. If a factor--for example, running--is found to be associated with the accident population more than with the exposure population, it should be considered relatively hazardous. If another factor--for example, walking--is found more often in the exposure population than it is in the accident population, it should be considered to be relatively less hazardous, or safe.

Hazard scores were developed to analyze the relationship between the occurrence of certain factors in the accident population and their occurrence in the general population at risk. These hazard scores are the ratio created by dividing the percentage of occurrence of a characteristic in either the accident population or the exposure population by the percentage of occurrence in the other population. In order to maintain an interval scale, the larger percentage is always divided by the smaller percentage. Thus, hazard scores always have an absolute value greater than or equal to 1.0. If the accident population had the larger percentage--an indication that more hazard is associated with the characteristic--the hazard score is presented as a positive number. If the exposure population had the larger percentage, the hazard score is presented as a negative number--an indication that less hazard is associated with the characteristic.

Three types of hazard scores were examined: site, pedestrian volume, and PV. The site hazard scores are based on how frequently sites with various characteristics occur in the accident population relative to the general population of sites at risk. The pedestrian volume hazard scores are based on the percentage of the total national projection of pedestrians crossing found at each type of site. The PV hazard scores are based on the exposure measure PV--the number of pedestrians (P) times the number of vehicles (V). Like the pedestrian volume hazard score, it is based on the percentage of the PV exposure occurring at sites with certain characteristics.

In order to simplify the discussion associated with relative hazard, only the PV scores are presented at this time. In the remainder of this paper the relative hazardousness, in terms of PV exposure, associated with roadway and intersection characteristics, pedestrian and vehicle characteristics, and accident characteristics will be addressed.

Roadway and Intersection Characteristics

Hazard scores for many descriptive factors associated with the roadway and the intersection were computed. Figure 5 shows the relative hazard associated with some selected roadway and intersection characteristics.

Roadway Characteristics	Percent of National Projection of: Accidents	Percent of National Projection of: PxV Exposure	P x V Hazard Score (Less Hazard / More Hazard)
Roadway Functional Classification			
Major Arterial	17.0	8.1	+ 2.1
Collector-Distributor	30.8	61.2	- 2.0
Local Street	39.4	24.0	+ 1.6
Other	12.9	6.7	+ 1.9
Pedestrian Accommodations			
No Sidewalks or Pathways	23.2	10.7	+ 2.1
Sidewalk (one or both sides)	76.7	89.3	- 1.2
Street Lighting			
None	14.5	1.2	12.1
Present	85.5	98.8	- 1.2
Land Use			
100% Residential	21.7	6.5	+ 3.3
Commercial	47.7	71.8	- 1.5
Mixed	30.6	21.8	+ 1.4
Lane Configuration			
2x2	48.7	29.0	+ 1.7
2x4	34.2	19.3	+ 1.8
4x4	17.0	51.7	- 3.0
Signalization			
No Signalization	63.3	31.8	+ 2.0
Red, Green, Amber (RGA)	12.1	10.1	+ 1.2
RGA + Pedestrian, Signal	24.7	58.2	- 2.4
Crosswalks			
Not Marked	61.2	24.8	+ 2.5
Marked	38.8	75.2	- 1.9

FIGURE 5 Relative hazard: selected roadway and intersection characteristics.

The PV score for the roadway functional classification variable indicates that both major arterials and local streets are relatively hazardous. Major arterials, for example, have 17.1 percent of the accidents yet account for only 8.1 percent of the PV exposure. The hazard score of +2.1 is produced by dividing 17.1 by 8.1. Because the sites have more accidents than exposure, the hazard score is positive, indicating that more hazard is associated with the major arterials. Collector-distributors, on the other hand, represent less hazard to pedestrians.

The relative hazardousness of sites with and without sidewalks is shown under the pedestrian accommodations variable. Sites with no sidewalks represent about one-tenth of the PV exposure; they account for only about one-fourth of the accidents. The PV hazard score shows that they are 2.1 times overrepresented when pedestrian and vehicle volumes are considered.

The data on street lighting show an even larger effect. Sites with no street lighting account for 14.5 percent of the accidents and get only 1.2 percent of the PV exposure. The PV hazard score of +12.1 indicates that locations with no street lighting represent a great hazard to pedestrians.

The land use variable shows the effect of adjoining land use on relative hazardousness. Although 100 percent residential areas are relatively common, the proportion of the pedestrian volumes found in these locations is almost exactly the same as the proportion of accidents. However, because vehicle volumes are low, the PV hazard score (+3.3) indicates that 100 percent residential areas are hazardous. Commercial and industrial areas are relatively safe (PV = -1.5), whereas mixed residential areas are only somewhat hazardous (PV = +1.4).

Also shown is relative hazardousness associated with signalization. Sites with no signal are more hazardous (PV = +2.0) than sites with a red, green, and amber (RGA) signal (PV = +1.2). Sites with an RGA signal and a pedestrian head are relatively less hazardous (PV = -2.4).

The PV hazard scores for sites with crosswalks indicate that far less hazard (PV = -1.9) is associated with marked crosswalks than with locations with no marked crosswalks (PV = +2.5).

Pedestrian and Vehicle Characteristics

Unlike the previously described site characteristics, because the factors are not site specific, it is not possible to generate three separate hazard scores for site, pedestrian volume, and PV exposure. In the remaining discussion a single hazard score is presented. This score is based on the percentage of the accident-involved pedestrians or vehicles and the percentage of the pedestrians or vehicles observed. Figure 6 shows the relative hazardousness associated with various pedestrian and vehicle characteristics. The data on pedestrian age are particularly interesting. It has long been known that pedestrian accidents are a particular problem for the very young and the elderly. The data shown reveal that the very young and the elderly are overinvolved in pedestrian accidents relative to their exposure as pedestrians. Surprisingly, the data on pedestrian sex and accompaniment (being alone or with others) did not reveal a similar effect. The proportion of pedestrians exposed was almost exactly the same as the proportion of pedestrian accidents.

Pedestrian and Vehicle Characteristics	Percentage of: Pedestrian Accidents	Percentage of: Pedestrians or Vehicles Observed	Hazard Score (Less Hazard / More Hazard)
Pedestrian Age			
1-4 years old	8.3	1.0	+8.3
5-9	21.6	5.4	+4.0
10-14	12.2	10.1	+1.2
15-19	10.9	11.5	-1.1
20-29	18.4	22.6	-1.2
30-59	15.8	41.7	-2.6
60+	12.8	7.7	+1.7
Pedestrian Mode			
Walking	47.1	88.8	-1.9
Running	52.9	11.2	+4.7
Pedestrian Crossing Location			
Crosswalk	24.0	54.3	-2.3
Within 50' of Intersection	24.1	9.4	+2.6
Diagonally Across Intersection	0.9	1.7	-1.9
Midblock	51.0	34.6	+1.5
Pedestrian Signal Response			
With Signal: Green	51.3	90.4	-1.8
Against Signal: Red	48.7	9.6	+5.1
Vehicle Action			
Going Straight	90.0	84.6	+1.1
Turning Right	3.8	7.7	-2.0
Turning Left	4.6	7.2	-1.6
Right Turn on Red	1.6	0.5	+3.2
Vehicle Type			
Cars	79.3	83.5	-1.1
Vans, Pickups	12.4	11.6	+1.1
Trucks, Other	2.3	2.4	-1.0
Buses	2.0	0.7	+2.9
Taxis	0.7	0.8	-1.1
Motorcycles	3.3	1.0	+3.3

FIGURE 6 Relative hazard: selected pedestrian and vehicle characteristics.

Running has long been recognized as a frequently occurring precipitating factor in pedestrian accidents. Over half of the pedestrians struck by vehicles were running, yet only one-tenth of pedestrians observed were running. Thus, a hazard score of +4.7 is associated with running.

The data on crossing location indicate that it is more hazardous to cross within 50 ft of an intersection (hazard score = +2.6) than it is to cross midblock (hazard score = +1.5). It is by far safer to cross in a crosswalk (hazard score = -2.3) than at any other location. Somewhat surprisingly, it was found that crossing diagonally across an intersection resulted in reduced hazard (hazard score = -1.9). However, this score is based on a small percentage (0.9 percent) of the accidents and should be carefully considered.

The response of pedestrians crossing at signalized intersections was examined. It was found that about half (48.7 percent) of the pedestrians struck had crossed against the signal, whereas only 9.6 percent of the pedestrians observed crossed against the light. The hazard score (+5.1) indicates that crossing against the signal is indeed a hazardous activity. Clearly, efforts to improve signal compliance would result in an improvement in pedestrian safety.

Figure 6 also highlights the relative hazard associated with various vehicle characteristics. Vehicles were observed to turn, either right or left, about twice as often as they were found to be turning in pedestrian accidents. The hazard scores for turning right (-2.0) and turning left (-1.6) indicate that these vehicle turning maneuvers do not result in increased risk to pedestrians. The data on right turn on red (RTOR) indicate the opposite effect. RTOR vehicles are overinvolved in accidents relative to their involvement in the exposure population. The hazard score (+3.2) indicates that RTOR presents a hazard to pedestrians.

The hazard scores associated with various types of vehicles indicate that buses (+2.9) and motorcycles (+3.3) present a hazard to pedestrians. The other vehicle types--cars, vans, trucks, and taxis--are involved in accidents in almost exactly the same proportion as they were observed in the exposure population.

Accident Characteristics

Two characteristics of pedestrian accidents will be described in this section: the time of day of occurrence and the accident type. Each of these characteristics will be described relative to the exposure data that were collected.

In Figure 7 the occurrence of the national projection of pedestrian accidents is plotted by time of day. Also shown are the percentage of the pedestrian volumes and the percentage of the PV exposure measures observed during each hour of the day. The accident curve shows a slight early a.m. peak, a major early afternoon peak, and a minor early evening peak. Although the curves for the pedestrian and the PV exposure measures tend to follow one another, they do deviate from the accident profile in several places. The relatively low rate of accident occur-

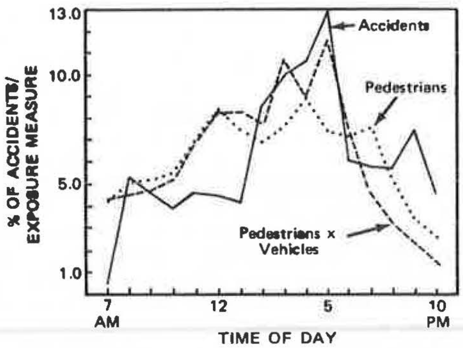

FIGURE 7 Pedestrian activity and pedestrian-vehicle exposure by time of day.

rences in the late morning indicates that hazard to pedestrians is lowest at that time. The traditional afternoon peak in pedestrian accidents is shown to closely follow a similar peak in the PV exposure measure plot. Accidents are occurring only slightly more often than would be expected on the basis of PV exposure. In the early evening, however, a large relative separation occurs between the curves. Both the pedestrian and the PV exposure measures show a continual decline, whereas the accident rate remains relatively stable and even shows a modest increase at 9:00 p.m. This indicates that periods of darkness, after 8:00 p.m., represent the greatest relative hazard for pedestrians.

Figure 8 shows a plot of the PV hazard scores by time of day. The relative safety associated with early and midday pedestrian exposure is shown in contrast to the increase in hazard after 7:00 p.m.

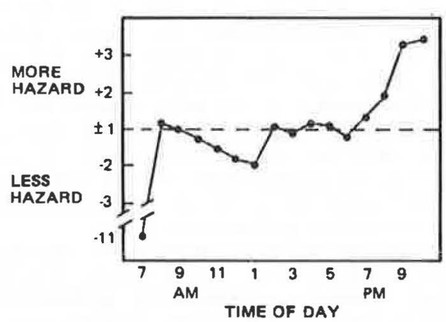

FIGURE 8 PV hazard score by time of day.

Each accident report in the sample was reviewed and assigned to an accident type. Each pedestrian observed during the pedestrian activity sampling portion of the field data collection was also assigned to an accident type. The field researchers simply coded the appropriate accident type in response to the question, "If the pedestrian had been struck during the time that he or she was being observed, into what type would the accident have been classified?" The accident types were based on the behavioral activities of the pedestrians when they were struck. The relative frequency of the accident types in the accident population and in the exposure population was used to generate a hazard score.

Figure 9 shows the data on the relative hazard associated with the various accident types. Four accident types were found to have negative scores, an indication that there is less hazard associated with these pedestrian activities. Not surprisingly, a pedestrian on the sidewalk--not crossing--was the

Accident Type	Percentage of Pedestrian Accidents	Percentage of Pedestrians Observed	Hazard Score (Less -5 -3 -1 +1 +3 +5 More)
Pedestrian on Sidewalk—Not Crossing	3.3	16.5	5.0
Intersection Crossing—Walking	12.1	52.5	4.4
Trapped: Changing Light	0.6	2.2	-3.7
Exiting-Entering Parked Vehicles	3.2	6.8	-2.1
Midblock Dart-out	33.0	1.2	27.5
Bus Stop Related	1.9	0.1	19.0
Vehicle Turn-Merge	4.9	0.4	12.3
Vendor, Ice Cream Truck-Related	1.7	0.2	8.5
Right Turn On Red	1.4	0.2	7.0
Disabled Vehicle-Related	1.7	0.3	5.7
Crossing Expressway	0.4	0.1	4.0
Multiple Threat	2.3	0.8	2.9
Intersection Dash	11.1	5.4	2.1
Playing in Roadway	3.7	1.8	2.1
Walking Along Roadway	6.9	4.6	1.9
Midblock Crossing-Walking	9.4	6.3	1.5
Hitchhiking	0.1	0.1	1.0
School Bus-Related	0.2	0.0	1.0
Mailbox Related	0.0	0.5	1.0

FIGURE 9 Relative hazard: accident types.

safest accident scenario; walking across the roadway at an intersection was the second safest. A surprising 2.2 percent of the pedestrians observed were trapped by a changing light. Because only 0.6 percent of the accidents involved that situation, the hazard score of -3.7 indicates that the situation is not a hazardous one.

The midblock dart-out is by far the most common accident type, accounting for one-third of all pedestrian accidents. However, darting out was rarely done by the pedestrians observed, only 1.2 percent. The +27.5 hazard score shows this behavior to be by far the most hazardous. Other less frequently occurring accident types were also found to have high positive hazard scores: bus-stop related, +19.0; vehicle turn-merge, +12.3; and vendor, ice cream truck related, +8.5. The RTOR accident type also had a high positive hazard score, +7.0. This is supportive of the high hazard (+3.2) previously reported to be associated with RTOR as a vehicle action. The hazard scores for RTOR as an accident type and as a vehicle action are different because they are based on the proportions associated with two different distributions.

Three other accident types accounted for relatively frequently occurring scenarios: intersection dash (11.1 percent), walking along the roadway (6.9 percent), and midblock crossing (9.4 percent). These accident types had positive hazard scores of +2.1, +1.9, and +1.5, respectively. Playing in the roadway accounted for 3.7 percent of the accidents. Interestingly, a total of 1.8 percent of the pedestrians observed were also playing in the roadway. Although a hazard score of +2.1 results, this activity is not as hazardous as might have been expected.

CONCLUSIONS

In the project described in this paper a great deal of useful data was collected on the characteristics of pedestrians and the nature of pedestrian exposure. Only a small fraction of the large data base has been presented here.

The data on pedestrian characteristics provide an indication of what people are doing, where they are doing it, when they are doing it, as well as the kind of people that make up the population of pedestrians. This information is valuable in developing a walking environment designed for the needs and characteristics of the pedestrian population.

The data on pedestrian exposure measures provide an indication of the nature of various kinds of pedestrian-vehicle interactions. By examining areas and locations where pedestrian exposure to vehicular traffic is most frequent, the efficiency and safety of the pedestrian environment can be improved.

The data on relative hazard provide an indication of the risk associated with various roadway, intersection, vehicle, and pedestrian characteristics. This information identifies those places and persons most likely to have a pedestrian accident, based on exposure. This provides an effective way to target locations for safety improvements.

The hazard scores for the various accident types provide an indication of the relative hazard associated with accident-precipitating pedestrian activities. This information can be effectively used to target pedestrian safety countermeasures.

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Midblock Crosswalks: A User Compliance and Preference Study

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ABSTRACT

This study documents the impact of traffic control present at marked midblock crosswalks (MBCs) in an urban area on user compliance and preference. The behavior study indicates that pedestrian compliance is independent of traffic control at MBCs whereas motorist compliance is highest under signalized control. Conflicts between pedestrians and vehicles are more frequent at the unsignalized MBC. The preference study indicates that users perceive the unsignalized MBC to be unsafe, although the same crosswalks are rated highest in crossing convenience. Finally, motorists surveyed indicated that overhead devices (signs, flashing lights) provide effective advance warning of MBCs for approaching traffic.

The competition for urban street space between pedestrian and vehicular traffic (moving or stationary) has been a long-standing problem facing transportation engineers and planners in many U.S. cities. Nonintersection or midblock crosswalks (MBCs) have often been introduced to accommodate natural pedestrian flows at such locations. However, some of the installations have sprung up as a result of community action, business pressure, or political considerations rather than engineering judgment.

Although considerable research has been undertaken on the general problem of pedestrian safety, aspects unique to the MBC have yet to be thoroughly investigated, especially for the marked but unsignalized MBC. Foremost among these problems are the following:

1. Pedestrian crossings at midblock locations are generally unexpected by the motorist [Manual on