Pedestrian Crash Types: 1990s Update

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A report is given on an application of the NHTSA pedestrian crash-typing system for categorizing pedestrian–motor-vehicle crashes according to the specific sequence of events leading up to individual crashes. Results are based on a recent sample of over 5,000 pedestrian crashes drawn from six states and reported by police. Over 80 percent of the pedestrian crashes fell into the following crash type categories: vehicle turn or merge (9.8 percent), intersection dash (7.2 percent), driver violation at intersection (5.1 percent), other intersection (10.1 percent), midblock dart or dash (13.3 percent), other midblock (13.1 percent), not in roadway and waiting to cross (8.6 percent), walking along roadway (7.9 percent), and backing vehicle (6.9 percent). These crash types were found to vary according to the characteristics of the pedestrian and factors of the location, environment, and roadway. The process of typing pedestrian crashes can be a valuable tool at both the state and local level for developing more highly effective countermeasures to reduce the annual toll of nearly 100,000 pedestrians killed and injured in traffic crashes.

Each year in the United States approximately 5,500 pedestrians are killed and 90,000 are injured in collisions with motor vehicles (*1*). Pedestrians make up 14 percent of the total of U.S. or traffic fatalities, and in some larger urban areas this percentage is 40 percent or greater.

The development of effective countermeasures to help prevent pedestrian crashes is hindered by insufficient detail in computerized files on state motor-vehicle crashes. Analysis of existing crash-file data can provide information on where pedestrian crash events occur (city streets, two-lane rural highways, intersection locations, and so forth), when they occur (time of day, day of week, and so forth), and specifics about to whom they occur (age of victim, gender, alcohol status, and so forth), but can provide very little information about the actual sequence of events leading up to a crash.

To address this situation the National Highway Traffic Safety Administration developed a system of typing pedestrian crashes. Each identified crash type is defined by a specific sequence of events, and each generally has precipitating actions, predisposing factors, and characteristic populations or locations that can be targeted for interventions. The original pedestrian accident typology was developed and applied during the early 1970s (*2–5*). Examples of pedestrian–motor-vehicle crash types include the following:

- Pedestrian darts out into traffic midblock,
- Pedestrian is struck from behind while walking or running along a road in the same direction as traffic,
- Vehicle turning at an intersection strikes a pedestrian, and
- Pedestrian is struck by backing vehicle.

A similar typology was later developed for bicycles (*6*).

NHTSA is currently applying its typologies to the subset of pedestrian and bicycle crashes identified through the General Estimates System (GES). GES is a nationally drawn probability sample of police-reported motor-vehicle crashes. As part of this effort, approximately 1,700 pedestrian and 800 bicycle crashes are being typed each year.

The purpose of the described research was threefold: to apply the basic NHTSA pedestrian crash typology to a different and larger sample of crashes; to examine the particular role of roadway and locational factors in pedestrian crashes; and to explore possible refinements to the coding system. A parallel effort was undertaken for bicycles (*7*). Although the development of countermeasures to reduce the frequency and severity of pedestrian–and bicycle–motor-vehicle crashes is a logical extension to the study, it was not a part of the research described.

METHOD

Pedestrian crash data were obtained from six U.S. states: California, Florida, Maryland, Minnesota, North Carolina, and Utah. These states were chosen to represent a cross section of urban and rural locations from different regions of the country. For each participating state a stratified sample of approximately 830 pedestrian crashes was drawn that represented approximately equal numbers of crashes from rural and small communities, medium-sized communities and cities, and larger cities. A copy of the actual police report was obtained for each identified crash, as well as the computerized crash and roadway data maintained by the state.

To receive training in the coding process members of the project team traveled to Washington, D.C., and met with the contractors responsible for coding GES pedestrian and bicycle data. The basic approach followed was the manual crash-typing procedure as outlined in *Manual Accident Typing for Pedestrian Accidents: Coder's Handbook* (*8*). The procedure requires a review of the actual hard copy of the police crash report, including the reporting officer's diagram and description of the crash event. The coder is led through a hierarchical series of crash-type descriptions until the appropriate crash type is arrived at. Special situations such as a bus-related crash, a backing vehicle, and a pedestrian working or playing in a roadway appear early in the hierarchy, and so take precedence over later crash types, including intersection and midblock crossing situations.

The original pedestrian typology included 37 distinct crash types. In developing the coding system for the current project, several of the original crash types were further refined. For example, crash type 210, "pedestrian struck by driverless vehicle," was subdivided into crashes in which the pedestrian was originally the vehicle's driver (Type 210) and those in which the pedestrian was not the original driver (Type 211). As another example, when a pedestrian was struck while walking along a road with traffic, additional codes were added to identify whether the vehicle approached from in front of or behind the pedestrian (Types 532 and 534, respectively). The

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"other—weird" category was also subdivided into a number of distinct crash types, "including lying in road," "suicide," "assault with vehicle," and "sitting/leaning/clinging to vehicle."

All coders participated in a detailed in-house training process that involved reviewing and coding identical sets of crash reports, then discussing the results as a group to reach consensus on the correct coding. During the course of the study a subset of reports was also coded by each of the project's four primary data coders, and inter-rater reliability was checked using Cohen's kappa statistic. Results showed substantial agreement among the coders (*9*).

In addition to the crash type a number of other variables were coded by the researchers based on their reviews of crash report hard copy. These included more detailed roadway and locational characteristics data (crosswalk and sidewalk status, road crossing width, private property details, and so forth), as well as the vehicle, roadway, environmental, pedestrian, and driver factors contributing to a crash. In general, information that could be obtained directly from a state's computerized crash file (such as pedestrian age, roadway classification, time of the crash, and so forth) was not coded unless variable formats across the states were not compatible.

Coding was carried out directly on computers using a specially prepared data entry screen and SAS software. After all the manual coding was completed cases were linked to the computerized crash data from each state to create a final analysis file.

The data analysis was primarily descriptive and included single-variable frequency distributions and two- and three-way cross-tabulations of crash type by other variables of interest. One approach used in reporting results was to look for patterns of over- or under-representation of a variable within a particular crash type. For example, if a crosstabulation of crash type by pedestrian age showed that pedestrians aged 9 and younger were involved in 19 percent of all pedestrian crashes but 41 percent of intersection dash crashes, then this age group would be reported as overrepresented within intersection dash crashes.

RESULTS

Overall Crash Types

The results presented focus on the major categories of pedestrian crash types. A full report on the project (*9*) contains the crash type results as well as an overview of the various pedestrian, motor-vehicle operator, temporal and environmental, locational, roadway, and vehicle factors in pedestrian crashes. Another separate report (*10*) presents more detailed information on the individual crash types, including diagrams and graphic displays of data.

Table 1 shows the complete distribution of crash types coded for the combined six-state sample. The types are listed and grouped according to the original NHTSA typology, with the additional subcategories inserted. Given the large number of crash types appearing in the table (61 in all), numbers and percentages for many subcategories are small. In the Special Circumstances category each of the crash types identified represents less than 1 percent of all sample cases. However, in certain locations these percentages may be significantly higher. For example, crashes in which a pedestrian (most often a young child) is struck walking to or from an ice-cream truck or other vendor (Type 130) can only occur in areas where this type of vending takes place. The study sample, however, included rural and urban areas and communities that might not have been served by ice-cream trucks and other vendors catering to children.

Crashes categorized under Vehicle Specific most frequently involved a backing vehicle making them Type 220. This type accounts for nearly 7 percent of the sample pedestrian crashes. Pedestrians were stuck by driverless vehicles in just over 2 percent of cases (Types 210 and 211). In the majority of these cases a pedestrian had been the driver of a vehicle and was struck by it after exiting. Disabled-vehicle crashes represent another 2 percent of the total. In these, pedestrians were most often struck when they were standing near or working on disabled vehicles (Type 320), as opposed to walking to or from the vehicles (Type 310). Each of another two crash types, one involving pedestrians working in the roadway (construction workers, trash collectors, and others) and one involving pedestrians playing in the roadway, represents another 1 to 2 percent of cases.

Overall, approximately 8 percent of crashes occurred when a pedestrian was walking along a roadway. Most frequently a pedestrian was struck from behind when walking with, as opposed to against, traffic (Type 531, representing just over 5 percent of all crashes). Less than 2 percent of the crashes involved a pedestrian walking against traffic (Types 532 and 534). These data appear to indicate a much higher risk associated with walking with traffic, although without appropriate exposure data no definite conclusions can be drawn.

Just under 9 percent of pedestrians were struck when they were not in a roadway. In the vast majority of these cases both a pedestrian and a vehicle were an in off-road location, such as a parking lot or driveway (Type 620). In a smaller percentage of cases a vehicle either left the road and struck a pedestrian (Type 621) or struck a pedestrian who was waiting to cross a road at or near the curb (Type 610 or 611).

Nearly one-third of the crashes were coded in the 700 series, Intersection-Related. (Alleys and driveways were considered intersections only if controlled by a traffic signal.) Of these, about one-third (or 10 percent overall) involved a turning vehicle (Type 720). Two other frequent intersection crash type subcategories were the "intersection dash," in which a motorist's view of a pedestrian was blocked until an instant before impact or a pedestrian was running (Type 730, 7.2 percent of all crashes), and the "driver violation, intersection," (Type 760, 5.1 percent of all crashes). The "intersection—other" category includes all those crashes that could not otherwise be classified (Type 790, 2.1 percent of all crashes). (It should be noted that not all crashes occurring at intersections were assigned a 700 code, because some involved circumstances that placed them higher in the crash-typing hierarchy. For example, a pedestrian struck while standing on a curb waiting to cross a road would have been coded as a Type 610 or 611 crash even if the curb was located at an intersection.

Midblock events were the second major pedestrian crash type grouping, representing over one-fourth (26.4 percent) of all crashes. Most common was the "midblock dash" (Type 830, 8.7 percent of all crashes), defined as a situation in which a pedestrian was running and a motorist's view was not obstructed. The midblock "dart-out" (Types 821, 822, and 829), in which a motorist's view was obstructed until just before impact, represents just under 5 percent of cases. Most often this crash type subcategory involved a pedestrian being struck before crossing half a roadway. Again, it should be noted that some Midblock category events (playing in road, struck by schoolbus, and so forth) could have been otherwise coded because of the hierarchy.

TABLE 1 Distribution of Pedestrian Crash Types

Crash Type	N	Percent*
Special Circumstances	22	0.4
110 Commercial bus-related	22	0.4
120 School bus-related	40	0.8
130 Vendor/ice-cream truck	16	0.3
140 Mailbox-related	33	0.7
150 Exiting/entering parked vehicle	133	2.6
Vehicle Specific		
210 Driverless vehicle - ped. was driver	80	1.6
211 Driverless vehicle - ped. not driver	24	0.5
220 Backing vehicle	351	6.9
230 Hot pursuit	5	0.1
	460	9.1
Disabled/Emergency Veh-Related		
310 Walking to/from disabled vehicle	9	0.2
320 Disabled vehicle related	105	2.1
330 Emergency/police veh. related	10	0.2
	124	2.4
Working/Playing in Roadway		
410 Working on roadway	69	1.4
420 Play vehicle-related	35	0.7
430 Playing in roadway	48	0.9
	152	3.0
Walking along Road/ Crossing Expressway		
510 Hitchhiking	15	0.3
520 Expressway crossing	25	0.5
531 Walking with traffic, struck from behind	257	5.1
532 Walking against traffic, struck from behind	76	1.5
533 Walking with traffic, struck from front	5	0.1
534 Walking against traffic, struck from front	7	0.1
539 Walking along rd. - side unknown	15	0.3
	400	7.9
Not in Road		
610 Waiting to cross at/near curb - veh. turning	18	0.4
611 Waiting to cross at/near curb - veh. not turning	14	0.3
620 Ped. and veh. not in roadway	346	6.8
621 Ped. not in roadway, veh. left roadway	58	1.1
	436	8.6
Crash Type	**N**	**Percent**
Intersection-Related		
710 Multiple threat at intersection	64	1.3
720 Vehicle turn/merge	497	9.8
730 Intersection dash	363	7.2
740 Trapped	41	0.8
750 Ped. walks into veh., unknown	18	0.4
751 Ped. walks into veh., instantaneously	13	0.3
752 Ped. walks into veh., non-instantaneously	11	0.2
760 Driver violation, intersection	259	5.1
790 Intersection - Other	109	2.1
791 Standing in road at intersection	14	0.3
792 Instantaneous step into road	57	1.1
793 Misjudged gap when crossing	25	0.5
794 Walking in road prior to impact	159	3.1
	1630	32.1
Midblock		
810 Multiple threat-midblock	46	0.9
821 Dart-out, first half	176	3.5
822 Dart-out, second half	50	1.0
829 Dart-out, can't specify	6	0.1
830 Midblock dash	442	8.7
840 Ped. walks into vehicle - unknown	34	0.7
841 Ped. walks into veh. - instantaneously	21	0.4
842 Ped. walks into veh. - non-instantaneously	18	0.4
890 Midblock - Other	209	4.1
891 Standing in road - midblock	47	0.9
892 Instantaneous step into road-midblock	60	1.2
893 Misjudged gap when crossing - midblock	35	0.7
894 Walking in road - midblock	197	3.9
	1341	26.4
Other or Inadequate Information		
910 Other - weird	85	1.7
911 Lying in road	22	0.4
912 Suicide	6	0.1
913 Assault with vehicle	55	1.1
914 Domestic/dispute	76	1.5
915 Sitting/leaning/clinging to vehicle	40	0.8
916 Result of vehicle-vehicle crash	61	1.2
917 Result of vehicle-object crash	25	0.5
920 Inadequate information	27	0.5
	397	7.8
All Crashes	**5,073**	

* Column percents

An attempt was made to identify some of the specific crash situations that would normally be coded only as "Other—Weird" (Type 910). Included in this atypical group were domestic or other dispute-related pedestrian crashes (76 cases), purposeful vehicular assaults (55 cases), pedestrian events resulting from a vehicle-vehicle or vehicle-object collision (61 and 25 cases), and situations in which a pedestrian had been sitting, leaning against, or clinging to a vehicle (40 cases). In 22 cases a pedestrian was lying in the road before a crash, and 6 cases were identified as likely suicide attempts.

The large number of individual crash types in Table 1 makes it difficult to draw conclusions from the table and to examine other crash type variables of interest, such as the age of the pedestrian, time of day when the crash occurred, roadway type, and so forth. To facilitate data analyses the individual crash types were distributed among 15 subgroups, which correspond closely to the original NHTSA crash typology. These subgroups are used in the remaining tables.

Pedestrian Characteristics

Table 2 shows the age distribution of pedestrians for each of the 15 pedestrian crash subgroups and all pedestrian crashes combined, allowing identification of the age groups most likely to be involved in each type of crash, as well as particular crash types within which

TABLE 2 Pedestrian Crash Types by Age of Pedestrian

Pedestrian Crash Type Subgroup	Pedestrian Age* 0-9	10-14	15-19	20-24	25-44	45-64	65+
Bus related	23.8	23.8	35.7	2.4	9.5	2.4	2.4
Other vehicle-specific	37.5	13.6	3.4	4.6	21.6	8.0	11.4
Driverless vehicle	13.7	1.4	6.8	9.6	37.0	16.4	15.1
Backing vehicle	15.4	3.2	7.5	12.5	30.1	12.5	18.6
Disabled vehicle related	2.5	1.7	7.6	14.4	53.4	15.3	5.1
Working/playing in road	31.7	14.8	6.3	7.0	25.4	12.0	2.8
Walking along roadway	1.3	6.9	17.4	14.3	43.7	11.5	4.9
Not in road	14.3	10.0	13.4	9.4	30.6	12.0	10.3
Vehicle turning at intersection	4.4	8.3	9.8	9.1	33.3	21.2	13.9
Intersection dash	40.6	23.1	13.2	2.9	13.5	4.1	2.6
Driver violation at intersection	7.9	13.0	11.1	9.1	33.6	11.1	14.2
Other intersection	8.5	14.9	9.5	8.9	31.0	12.6	14.7
Midblock dart/dash	55.2	16.2	6.0	4.1	12.5	2.9	3.2
Other midblock	14.1	7.8	9.7	8.9	33.3	15.3	10.9
Miscellaneous	4.1	7.5	18.5	14.6	40.3	9.4	5.5
All Crashes	18.7	11.1	10.9	9.0	29.7	11.4	9.2

*Row percents. Cases with unknown age excluded.

an age group is over- or underrepresented. Highlights include the following:

- Children aged 9 and younger were overrepresented in the following crash type subgroups: "bus-related," "other vehicle-specific" (vendor or ice cream truck–related, exiting or entering parked vehicle, and so forth), "working/playing in road," "intersection dash" and "midblock dart/dash";
- Youth aged 10 to 14 joined children under age 10 in being overinvolved in bus-related crashes, intersection dashes, and midblock darts and dashes. Nearly two-thirds of all intersection dashes and 71 percent of all midblock darts and dashes involved children and youth under age 15;
- Teens aged 15 to 19 composed over one-third of all pedestrians injured in bus-related crashes. They were also overrepresented within the subgroups "walking along roadway" and "miscellaneous" (assault with vehicle, domestic- or dispute-related, sitting, leaning or clinging to vehicle, and so forth);
- Pedestrians aged 20 to 24 were underrepresented in intersection dashes and midblock darts and dashes. They were overrepresented, however within the subgroups "disabled vehicle related," "walking along roadway," and "miscellaneous";
- Pedestrians aged 25 to 44 were also overrepresented within the subgroups "disabled vehicle related" and "walking along roadway." Over one-half of disabled-vehicle -related crashes involved pedestrians in this age group, as well as 44 percent of walking-along-roadway crashes. This group also comprised over one-third of pedestrians involved in driverless-vehicle crashes.
- Older adults (aged 45 to 64) were overrepresented in crashes involving turning vehicles at intersections, and to a lesser extent in driverless-vehicle and disabled-vehicle–related crashes.
- Senior adults (aged 65 and over) were overinvolved within the crash subgroups "backing vehicle," and "Driverless vehicle" and in intersection-related crashes (except for intersection dashes).

Although many of these age-related outcomes may reflect varying exposure levels, without additional data the causes of overinvolvement can only be surmised.

Gender results showed that whereas males composed just over 60 percent of all pedestrian crash victims, they represented over 80 percent of pedestrians struck while working in the roadway, 73 percent of those struck in disabled-vehicle–related crashes, and 71 percent of those struck while walking along a roadway. Females, on the other hand, comprised 39 percent of victims, and were more likely to be involved in bus-related crashes (65 percent), driverless-vehicle crashes (55 percent), crashes involving a vehicle turning at an intersection (57 percent), and intersection crashes involving a driver violation (52 percent).

Alcohol or drug use was noted for about 15 percent of pedestrians in crashes. Crash type subgroups in which crashes were most likely to involve alcohol or drug use include "walking along roadway" (30 percent) and the general categories "other midblock" and "other intersection" (31 percent and 23 percent, respectively). "Working/playing in road," "driverless vehicle," and "bus related" were all subgroups in which crashes were very unlikely to involve alcohol-impaired pedestrians.

Table 3 shows the injury severity distribution for pedestrians involved in the various crash type subgroups. Subgroups in which

TABLE 3 Pedestrian Crash Types by Pedestrian Injury Severity

Pedestrian Crash Type Subgroup	Injury Severity* No Injury	C	B	A	Fatal
Bus related	2.3	25.0	45.5	22.7	4.5
Other vehicle-specific	0.0	24.7	43.8	25.8	5.6
Driverless vehicle	1.4	24.3	36.5	35.1	2.7
Backing vehicle	2.4	39.2	35.8	20.8	1.7
Disabled vehicle related	2.5	24.2	31.7	32.5	9.2
Working/playing in road	3.5	32.2	37.1	25.9	1.4
Walking along roadway	1.5	23.9	34.3	27.2	13.2
Not in road	3.3	31.9	36.4	24.7	3.6
Vehicle turning at intersection	2.4	44.6	34.5	16.6	1.8
Intersection dash	3.4	25.4	37.6	29.4	4.2
Driver violation at intersection	2.4	32.2	37.6	22.7	5.1
Other intersection	3.0	27.2	33.6	30.8	5.4
Midblock dart/dash	2.4	23.2	38.8	30.0	5.6
Other midblock	1.5	23.0	28.7	35.7	11.1
Miscellaneous	3.8	26.5	36.8	25.7	7.3
All Crashes	2.5	28.7	35.3	27.4	6.1

*Row percents. Cases with unknown injury severity excluded.

TABLE 4 Pedestrian Crash Types by Hour of Day

Pedestrian Crash Type Subgroup	Hour of Day* 6 am - 9:59 pm	10 am - 1:59 pm	2 pm - 5:59 pm	6 pm - 9:59 pm	10 pm - 1:59 am	2 am - 5:59 am
Bus related	20.5	9.1	50.0	13.6	4.6	2.3
Other vehicle-specific	3.4	21.4	39.3	23.6	10.1	2.3
Driverless vehicle	9.6	24.7	42.5	16.4	5.5	1.4
Backing vehicle	12.3	25.6	28.8	18.9	10.5	3.9
Disabled vehicle related	13.6	14.4	16.9	30.5	17.8	6.8
Working/playing in road	17.2	22.1	31.0	25.5	2.8	1.4
Walking along roadway	13.6	7.2	16.2	34.7	21.3	6.9
Not in road	11.1	19.9	36.5	19.9	8.3	4.3
Vehicle turning at intersection	18.8	22.3	36.7	17.2	3.7	1.2
Intersection dash	9.4	12.3	47.9	23.4	5.7	1.4
Driver violation at intersection	15.3	20.6	31.1	23.0	9.3	0.8
Other intersection	11.4	12.4	32.7	27.6	11.4	4.5
Midblock dart/dash	7.3	14.7	45.1	26.4	5.3	1.2
Other midblock	9.4	12.7	27.4	31.3	14.5	4.7
Miscellaneous	8.9	13.7	23.4	23.4	19.8	10.9
All Crashes	11.5	15.9	33.1	25.1	10.5	3.8

*Row percents. Cases with unknown hour of day excluded.

crashes were most likely to result in a serious (A-level) or fatal (K-level) injury were "other midblock," "disabled vehicle related," "walking along roadway," and "driverless vehicle." Less severe crashes involved vehicles turning at intersections, backing vehicles, buses, and driver violations at intersection events. Speed was clearly a factor in these severity outcomes: crashes occurring along open stretches of roadway or at midblock locations are likely to involve higher speeds than crashes occurring at intersections. In addition, backing vehicles and buses are likely to be moving at relatively slower speeds when they strike pedestrians.

Locational and Environmental Characteristics

Analysis considered many locational, temporal, and roadway factors associated with crash events. Discussion will focus on a few of those factors.

Overall, two-thirds of the crashes occurred in urban areas and one-third in rural areas, a distribution reflective of the sampling approach adopted for the study (approximately equal numbers of crashes from rural areas, small communities and cities, and large cities). As could be anticipated the various intersection crash types were overrepresented within urban areas. Crash type subgroups more likely to be represented within rural areas included "disabled vehicle" (44 percent) and "walking along roadway" (44 percent).

One of the variables that was coded when it was encountered during the review of the hard copies of the police crash reports was private property as the crash location. The type of private property (e.g., parking lot, driveway, and so forth) was also coded. Most crash types' occurrences were almost entirely on public roadways; however, three occurred predominantly on private property. These were "not in road" (78 percent), "backing vehicle" (70 percent), and "driverless vehicle" (60 percent). Although not-in-road crashes include situations in which a pedestrian is struck while standing at or near a curb (i.e., on public property), nearly half (47 percent) of these events occurred in parking lots, and an additional 15 percent occurred in driveways or on the sections of sidewalks that cross driveways. Similarly, 45 percent of backing-vehicle crashes occurred in parking lots and 17 percent on driveways or on sidewalks. Finally, 35 percent of driverless-vehicle crashes occurred in parking lots and 20 percent occurred entirely in driveways.

The hour of the day when the pedestrian crashes occurred is shown in Table 4. Bus-related crashes are overrepresented in the early morning and late afternoon hours, coinciding with the peaks in their exposure. The subgroups "working/playing in road" and "vehicle turning at intersection" are overrepresented in the morning and early afternoon hours (from 6 a.m. until 2 p.m.). Driverless-vehicle crashes were especially frequent during the hours mid-morning to late afternoon, as were backing crashes between 10 a.m. and 2 p.m. In the period from 2 p.m. until 6 p.m., intersection dashes and midblock darts and dashes are overrepresented. Shifting to the nighttime hours, both disabled-vehicle–related and walking-along-roadway crashes are greatly overrepresented in the hours between 6 p.m. and 6 a.m. Also overrepresented in the 2-to-6-a.m. time period are not-in-road and other intersection and midblock crashes.

Results for light conditions were similar, and are shown in Table 5. Over 70 percent of crashes in the subgroups "bus related," "other vehicle-specific," "driverless vehicle," "backing vehicle," "working/playing in road," "vehicle turning at intersection," "intersection dash," "and midblock dart/dash" occurred during daylight hours. In contrast, only 34 percent of walking-along-roadway crashes and 40 percent of disabled-vehicle–related crashes occurred during daylight. Just under 42 percent of walking-along-roadway crashes and 37 percent of disable-vehicle–related crashes

TABLE 5 Pedestrian Crash Types by Light Condition

Pedestrian Crash Type	Light Condition* Day-light	Dawn/ Dusk	Dark, Street Light	Dark,No Street Light
Bus related	72.7	4.5	20.5	2.3
Other vehicle-specific	74.2	2.2	13.5	10.1
Driverless vehicle	82.4	4.1	4.1	9.5
Backing vehicle	72.0	3.2	19.1	5.7
Disabled vehicle related	40.0	6.7	16.7	36.7
Working/playing in road	74.7	8.2	11.6	5.5
Walking along roadway	33.5	5.5	19.4	41.6
Not in road	67.8	4.2	22.6	5.4
Vehicle turning at intersection	72.0	5.3	20.5	2.2
Intersection dash	70.9	4.5	20.4	4.2
Driver violation at intersection	63.1	2.7	32.9	1.2
Other intersection	53.8	4.4	34.8	7.0
Midblock dart/dash	73.4	5.7	14.7	6.2
Other midblock	46.8	3.4	32.1	17.7
Miscellaneous	49.5	3.8	28.6	18.1
All Crashes	60.6	4.6	23.3	11.6

*Row percents. Cases with unknown light condition excluded.

occurred on dark roadways with no street lights, compared with 12 percent for pedestrian crashes overall.

Roadway Characteristics

Information on the road system where pedestrian crashes occurred is presented in Table 6. (Information on the functional classification of roadways—arterial, collector, and so forth—was not consistently available across states.) Disabled-vehicle crashes were overrepresented on interstate roadways, U.S. routes, and state routes. Crashes in the subgroup "other intersection" were also overrepresented on U.S. and state routes. Crashes in the subgroups "working/playing in road" and "walking along roadway" were particularly likely to occur along county routes, whereas those in the subgroups "bus related," "other vehicle-specific," and "driver violation at intersection" were more likely than other crashes to occur on local streets. The "Other" column in Table 6 includes roads on private property and off-road locations; not-in-road, backing-vehicle, and driverless-vehicle crashes were all overrepresented in these types of locations.

Table 7 gives the detailed locations of pedestrians for each of the major crash type subgroups. Bus-related, intersection-related (including vehicle-turning, intersection-dash, driver-violation, and other crash types), and midblock crashes (including darts and dashes and other crash types) almost always involved a pedestrian being struck in the travel lane. Results for disabled-vehicle–related and walking-along-roadway crashes, on the other hand, indicate that large percentages of pedestrians involved in these crashes were on a road shoulder or at the edge of a travel lane when struck. One-half of not-in-road crashes were in parking lots, 17 percent on sidewalks,

TABLE 6 Pedestrian Crash Types by Road System

	Road System*					
Pedestrian Crash Type Subgroup	Interstate	US Route	State Route	County Route	Local Street	Other
Bus related	0.0	3.1	15.6	25.0	37.5	18.8
Other vehicle-specific	2.1	4.3	17.0	21.3	40.4	14.9
Driverless vehicle	3.5	1.8	8.8	22.8	24.6	38.6
Backing vehicle	0.0	2.6	7.7	10.3	28.9	50.5
Disabled vehicle related	17.7	13.9	27.8	21.5	12.7	6.3
Working/playing in road	2.2	7.8	10.0	34.4	33.3	12.2
Walking along roadway	4.0	10.5	22.2	34.8	23.4	5.2
Not in road	0.0	2.9	8.4	10.5	20.5	57.7
Vehicle turning at intersection	0.0	10.0	18.3	22.3	28.3	21.1
Intersection dash	0.5	4.3	22.2	22.7	38.2	12.1
Driver violation at intersection	0.0	7.4	24.7	19.8	38.3	9.9
Other intersection	0.0	14.0	28.8	18.1	27.1	12.0
Midblock dart/dash	0.0	8.7	19.7	27.0	33.0	11.6
Other midblock	0.2	10.4	28.0	22.6	30.6	8.2
Miscellaneous	1.7	6.7	15.5	26.5	31.5	18.1
All Crashes	1.3	8.2	19.9	22.8	29.1	18.6

*Row percents. Cases with unknown road system excluded.

TABLE 7 Pedestrian Crash Types by Detailed Pedestrian Location

	Pedestrian Location*					
Pedestrian Crash Type Subgroup	Travel Lane	Shoulder or Edge of Lane	Side-walk	Alley, Drive-way	Parking Lot	Other
Bus related	97.7	2.3	0.0	0.0	0.0	0.0
Other vehicle-specific	76.6	9.6	0.0	0.0	3.2	10.6
Driverless vehicle	26.2	5.8	1.0	20.4	36.9	9.7
Backing vehicle	22.6	2.6	6.3	13.1	44.9	10.6
Disabled vehicle related	58.1	30.7	0.0	1.6	1.6	8.1
Working/playing in road	79.0	7.9	0.0	1.3	1.3	10.5
Walking along roadway	53.0	41.2	0.3	0.3	0.0	5.2
Not in road	3.9	5.5	16.7	14.9	49.8	9.2
Vehicle turning at intersection	97.2	1.2	1.0	0.0	0.0	1.6
Intersection dash	100.0	0.0	0.0	0.0	0.0	0.0
Driver violation at intersection	98.5	0.8	0.0	0.0	0.0	0.8
Other intersection	98.8	0.2	0.0	0.0	0.0	0.0
Midblock dart/dash	99.3	0.0	0.0	0.3	0.0	0.4
Other midblock	96.7	1.2	0.0	0.0	0.5	1.6
Miscellaneous	50.1	10.4	4.7	3.1	13.0	18.7
All Crashes	74.2	6.4	2.3	3.0	9.3	4.8

*Row percents. Cases with unknown pedestrian location excluded.

and 15 percent in alleys or driveways. Driverless-vehicle crashes occurred most often in parking lots (37 percent), followed by travel lanes (26 percent), and then alley or driveways (20 percent). Backing-vehicle crashes were similarly distributed: 45 percent parking lot, 23 percent travel lane, and 13 percent alley or driveway.

Contributing Factors

A range of factors contributing to the occurrence of a pedestrian crash could be identified from the information provided on a crash report form. Contributing factors were divided among four categories (Pedestrian, Motor-Vehicle Operator, Roadway/Environment, and Vehicle), and up to three factors could be identified in each category for each crash report coded. For example, alcohol impairment, stepping into road, and lack of conspicuity might all be cited as Pedestrian contributing factors for one case, whereas "none indicated" might be coded for another case.

Overall, two-thirds of pedestrians (66 percent) were coded for at least one contributing factor. The factors most frequently coded under Pedestrian are as follows:

1. Ran into road (15 percent),
2. Failed to yield (11.8 percent),
3. Alcohol impaired (10.3 percent),
4. Stepped from between parked vehicles (7.1 percent), and
5. Walking or running in wrong direction (5.3 percent).

Several of these pedestrian behaviors are associated with specific crash types, such as "intersection dash," "midblock dash" and the various walking-along-roadway types. Other contributing factors that were indicated with some frequency include jaywalking (3.1 percent), stepping into the roadway (4.1 percent), failing to obey a traffic signal (3 percent), walking or standing in the road (3.1 percent), and lack of conspicuity (2.9 percent). Because conspicuity was only coded when the reporting officer made some documentation of the pedestrian not being visible to the motor-vehicle driver (e.g., "pedestrian wearing dark clothing" or "driver couldn't see the pedestrian"), results likely indicate a conservative estimate of the problem; the same may be true for many of these contributing factors. Pedestrian actions that were only rarely cited as contributing factors include jogging in the road (15 cases), unsafe skateboard maneuver (13 cases), and unsafe rollerblade maneuver (6 cases). Without appropriate exposure data, however, the level of risk associated with such behaviors cannot be assessed.

In 55 percent of the cases one or more contributing factors were identified under Driver. The most frequently cited factors are as follows:

1. Hit and run (16.2 percent),
2. Failed to yield to pedestrian (15 percent),
3. Exceeded speed limit or safe speed (6.2 percent),
4. Improper backing (5.6 percent),
5. Safe-movement violation (4.8 percent),
6. Inattention or distraction (4.2 percent),
7. Reckless driving (3.4 percent), and
8. Alcohol impairment (3.1 percent).

Roadway/Environmental factors (blocked vision, road construction, and so forth) were coded for one-fourth of the crashes, and Vehicle factors (extended side mirrors, defective brakes, and so forth) were coded for just over 10 percent of the crashes.

DISCUSSION OF RESULTS

A report has been made on an application of the NHTSA pedestrian crash–typing system for categorizing pedestrian–motor-vehicle crashes according to the specific sequence of events leading up to individual crashes. The results reported are based on a sample of over 5,000 police-reported pedestrian crashes drawn from six geographically dispersed states.

The overall crash type distribution reported is similar to that obtained for the initial three years (1988 to 1990) of GES data (*Stutts, unpublished data*). The exceptions are slightly higher percentages of driverless- and backing-vehicle and walking-along-roadway crashes, coupled with lower rates of intersection and midblock crashes. These differences may be a reflection of a rural bias in this study's six-state sample.

Over 80 percent of the sample pedestrian crashes fell into the following subcategories listed in Table 1: under Intersection-Related "vehicle turn/merge" accounted for 9.8 percent of crashes, "intersection dash" for 7.2 percent, "driver violation, intersection" for 5.1 percent, and all other subcategories combined for 10.1 percent; under Midblock, "midblock dash" and the three "dartout" subcategories accounted for 13.3 percent of crashes and all other subcategories combined for 13.1 percent; under Not in Road, all subcategories combined to account for 8.6 percent of crashes; under Walking Along Road/Crossing Expressway, all subcategories combined to account for 7.9 percent of crashes; and under Vehicle Specific, "backing vehicle" accounted for 6.9 percent of crashes. These crash types varied according to the characteristics of the pedestrian involved, locational and environmental factors, and roadway factors. An understanding of the sequences of events leading to pedestrian crashes and the particular human, environmental, and roadway factors involved can lead to more effective development and targeting of countermeasures to prevent the occurrence of such crashes.

The original NHTSA typology based on 37 pedestrian crash types was expanded to 61 types for this study, allowing a better understanding of the specific circumstances contributing to particular type crashes, especially in the "other—weird" category, which otherwise was undefined. Without such detail it would be difficult to develop effective countermeasures against specific crash types. The inclusion of more detailed roadway and locational information also appears to be key to effective countermeasure development. For example, analysis indicated that nearly one-half of backing-vehicle crashes occurred in parking lots and 13 percent in driveways or alleys, a finding not available from the crash typing process alone.

Arguments can certainly be made for simplifying the crash typing process and reducing the number of individual crash types, especially in smaller communities with relatively few pedestrian crashes and limited resources for carrying out the crash typing, but it should be recognized that such loss of detail could hinder effective countermeasure development and implementation. Although individual states and communities can rely on the results of larger research projects such as the one described, it is important to recognize that situations vary from state to state, as well as among communities within a state. Therefore, crash typing can be a valuable tool at both the state and local level for reducing the annual toll of pedestrians killed and injured in traffic crashes.

ACKNOWLEDGMENTS

The authors would like to thank the Federal Highway Administration and the Centers for Disease Control and Prevention for their support of this research effort.

REFERENCES

1. *Traffic Safety Facts 1994*. NHTSA, U.S. Department of Transportation, 1995.
2. Snyder, M. B., and R. L. Knoblauch. *Pedestrian Safety: The Identification of Precipitating Factors and Possible Countermeasures*, Vols. I and II—Appendices. DOT FH-11-7312, U.S. Department of Transportation, 1971.
3. Knoblauch, R. L. *Urban Pedestrian Accident Countermeasures Experimental Evaluation*. Vol. II: Accident Studies. DOT HS-801-347, U.S. Department of Transportation, 1975.
4. Knoblauch, R. L. *Causative Factors and Countermeasures for Rural and Suburban Pedestrian Accidents: Accident Data Collection and Analysis*. FHWA HS-802-266, FHWA, U.S. Department of Transportation, 1977.
5. Knoblauch, R. L., W. Moore, and P. R. Schmitz. *Pedestrian Accidents Occurring on Freeways: An Investigation of Causative Factors, Accident Data Collection, and Analysis*. FHWA RD-78-169/171, FHWA, U.S. Department of Transportation, 1978.
6. Cross, K. D., and G. Fisher. *A Study of Bicycle/Motor Vehicle Accidents: Identification of Problem Types and Countermeasure Approaches*. DOT HS-803-315, U.S. Department of Transportation, 1977.
7. Hunter, W. W., W. E. Pein, and J. C. Stutts. Bicycle/Motor Vehicle Crash Types: The Early 1990s. In *Transportation Research Record 1502*, TRB, National Research Council, Washington, D.C., 1995, pp. 65–74.
8. *Manual Accident Typing for Pedestrian Accidents: Coder's Handbook*. NHTSA, U.S. Department of Transportation, undated.
9. Hunter, W. W., J. C. Stutts, W. E. Pein, and C. L. Cox. *Pedestrian and Bicycle Crash Types of the Early 1990's*. FHWA, U.S. Department of Transportation, 1995.
10. Hunter, W. W., W. E. Pein, and J. C. Stutts. *Pedestrian Crash Types: A 1990's Informational Guide*. FHWA, U.S. Department of Transportation, in press.

Publication of this paper sponsored by Committee on Pedestrians.