October 1981
Final Report

DOT HS-806-148

U.S. Department of Transportation
National Highway Traffic Safety Administration

Pedestrian Injury Causation Parameters—Phase II

John W. Garrett
A. Stephen Baum
Linda O. Parada

Calspan Field Services, Inc.
P.O. Box 400
Buffalo, New York 14225

Contract No. DOT HS-7-01579
Contract Amount $197,892

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. DOT HS-806 148	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle PEDESTRIAN INJURY CAUSATION PARAMETERS - PHASE II FINAL REPORT		5. Report Date October 1981 6. Performing Organization Code
7. Author(s) John W. Garrett, A. Stephen Baum and Linda O. Parada		8. Performing Organization Report No. ZS-6117-V-1
9. Performing Organization Name and Address Calspan Field Services, Inc. P.O. Box 400 Buffalo, New York 14225		10. Work Unit No. A12 11. Contract or Grant No. DOT-HS-7-01579
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration 400 7th Street, S.W. Washington, D.C. 20590		13. Type of Report and Period Covered Final Report April 18, 1977 - October 30, 1981 14. Sponsoring Agency Code

15. Supplementary Notes

CTM G.R. Toth, NHTSA, (202) 426-9124
F.J. Daniels, III, NHTSA, (202) 426-4820
R. Blodgett, NHTSA, (202) 426-1518

16. Abstract

This report describes data collection, quality control and data analysis procedures for a five-team program to study pedestrian injury causation factors. The data file contains 1,997 pedestrian accidents collected during a two and one-half year period from September 1977 to March 1980. The report describes the data sources, quality control measures, the data file and the case weighting procedures used in preparing the data for analysis. The study cases represent a sample of the pedestrian accidents occurring in the five collection areas. These samples were compared with the base rate data (all police reported pedestrian accidents) from the areas to determine the representativeness of the sample.

Data analysis includes evaluation of injury severity and injury types associated with impact speed, vehicle body style, injury source and pedestrian age. Other analyses include vehicle-pedestrian interactions, pedestrian orientation and injury severity, vehicle braking and injury type and severity and the effect of vehicle geometry on injury. Lower extremity injuries are evaluated in terms of pedestrian age and injury source. Emphasis throughout the analysis is placed on frontal impacts which are the most common. One section is also devoted to vehicle side impacts with pedestrians.

17. Key Words Pedestrian accident; pedestrian injury causation; pedestrian accident societal costs; pedestrian study quality control; impact speed and pedestrian injury; pedestrian data file	18. Distribution Statement Document is available to the public through the National Technical Information Service, Springfield, VA 22161.		
19. Security Classif. (of this report) None	20. Security Classif. (of this page) None	21. No. of Pages 296	22. Price

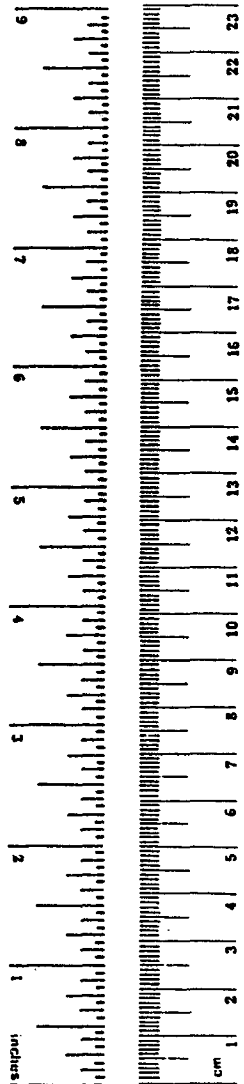
Form DOT F 1700.7 (8-69)

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
		VOLUME		
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	millimeters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
		VOLUME		
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F

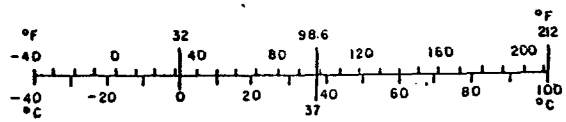


FIGURE 3. METRIC CONVERSION FACTORS

FOREWORD

This report was prepared for the National Highway Traffic Safety Administration (NHTSA) of the U.S. Department of Transportation under Contract No. DOT-HS-7-01579.

The report describes the study data which consist of 1,997 pedestrian accidents, the quality control procedures utilized and the data file. Data analysis is discussed in detail for vehicle frontal impacts with pedestrians which was the predominant impact type in the data. Side impacts with pedestrians are described in a separate section. An analysis of the costs associated with pedestrian accidents, based on the limited data collected for this purpose, is also presented.

John W. Garrett
John W. Garrett
Manager, Accident Research Division

TABLE OF CONTENTS

TABLE OF CONTENTS (CONTINUED)

LIST OF TABLES

LIST OF TABLES (CONTINUED)

LIST OF TABLES (CONTINUED)

LIST OF TABLES (CONTINUED)

LIST OF TABLES (CONTINUED)

LIST OF TABLES (CONTINUED)

LIST OF FIGURES

SUMMARY AND MAJOR FINDINGS

The objectives of the Data Analysis phase of the Pedestrian Injury Causation Study (PICS) were as follows:

- To identify those factors in pedestrian/motor vehicle accidents that are indicated statistically to be important in causing pedestrian injury severity.

- To identify relationships between pedestrians, their injuries, and motor vehicle design.

- To identify relationships between pedestrians, their injuries, and direct costs associated with pedestrian/ motor vehicle accidents.

- To examine the feasibility of determining injury severity distribution and costs (within the jurisdictions of the study), utilizing relations and correlations between police collectible data and more detailed accident investigations.

Data were collected by five teams located in the cities of Buffalo, Palo Alto, Los Angeles, San Antonio, and Washington, D.C. The participating teams collected a sample of police-reported pedestrian accidents over a period of two and one-half years. Only those accidents involving automobiles, pickup trucks, and vans were collected. The sampling criteria included: 100% of fatal accidents and a systematic random sample of all other pedestrian accidents such that each team collected a total (fatal and other combined) of 450 accidents. (Two teams--Los Angeles and Washington--started later than the other teams and the goal for each was 350 cases.) One team (Los Angeles), sampled fatal accidents rather than investigating 100% because of the large number of cases in that city.

The total cases collected involved 1,997 accidents, 2,021 vehicles and 2,068 pedestrians.

Data collection included obtaining the accident report prepared by investigating police, examination of the involved vehicle, contacting the driver, pedestrian and any witnesses, inspecting and documenting the scene of the accident, and obtaining a medical report on those pedestrians who were injured and treated at a medical facility. The investigation included photographs and measurement of exterior damage and other marks on the vehicle, and of the accident scene, in order that impact speed and the relationship between vehicle design features and injury could be determined.

The exterior of the automobile was inspected for pedestrian contact points, relevant vehicle damage and to obtain the vehicle identification number (VIN). Human data involved questions on vehicle maneuvers, driver actions, pedestrian height, weight, number of doctor visits, number of days off work and actions taken prior to impact. Medical information included the pedestrian's specific injuries, length of hospital stay, and requirements for special treatment (e.g., surgery, or radiology).

Quality Control Procedures

Quality control procedures for this program as well as report forms and a Coding Manual were developed by Calspan Field Services, Inc. (CFSI) consistent with the requirements of the original work statement. Quality control procedures encompassed two basic areas: first, periodic on-site visits to the teams to review operating procedures, case data coding and accident reconstruction to ensure that data were collected in a uniform and consistent manner and, second, case review, correction, computer editing and data processing were conducted at CFSI to produce a computer file of the PICS data.

The report forms were color-keyed as indicated for easy selection of the correct form in the field (an important consideration) and contain an identifying letter in the upper right hand corner. The report forms and other material are listed below in the sequence in which they are arranged for submission by individual teams.

Identification		Number of Pages	Color Key
-	Case Summary Report	5	White
-	Typical Police Report	-	White
A	Administrative Data Form	1	White
E	Environmental Data Form	4	Green
V	Vehicle Data Form(s)	8	Yellow
H	Human Data Form(s)	10	Blue
H1	Human: Medical Data, Supplement(s)	2	Blue
-	Case Photographs	-	

Quality control procedures for this study included case registration to identify the case, and to record the number of report forms and photographs submitted. Case coding was then checked and changed where necessary. Cases then were keypunched, verified and placed on magnetic tape. A computer edit was performed to 1) ensure that all data were present and in the proper sequence, 2) ensure that coded values were within the legitimate range and 3) check inter-code consistency for a number of key variables.

A sample of the police reported accidents was collected by each team. Consequently, it also was necessary to adjust for the sampling by weighting so that estimates of frequency of occurrence in the overall accident population could be made.

Findings - An Overview

- Accidents primarily involve a single vehicle and a single pedestrian.
- The pedestrian, unaware of impending danger, enters the path of the striking vehicle, most often from the right side of the vehicle.

- A majority (51%) of pedestrian accidents occur at a location with no intersection and no traffic control device.

- The driver of the striking vehicle generally is driving straight along the roadway immediately prior to the accident; if an evasive maneuver is attempted by the driver, it is usually brake application. Almost 95 percent of the calculated impact speeds are below 30 MPH and about 83 percent are below 20 MPH.

- After being struck (by the vehicle front in 74% of the accidents), the pedestrian is eventually thrown or knocked to the pavement.

- Almost half of the struck pedestrians are fifteen years old or younger.

- A pedestrian rarely escapes injury when struck by a vehicle; the median severity of the injury is an AIS 1, or minor. Consequently, a large proportion of the injuries are contusions and abrasions.

- The most prevalent source of pedestrian injury is the ground/pavement. For 30 percent of the cases, the ground/pavement caused the most severe injury and over 40 percent of all injuries can be attributed to pavement contact.

- Other significant sources of injury are: front bumper, grille, hood and fenders.

Vehicle Geometry, Impact Speed and Vehicle Pedestrian Interaction

- There is little indication that variations in bumper height have any marked effect on pedestrian kinematics. There was little variation in the bumper heights within the sample; approximately three quarters of the striking vehicles' bumpers were between 19 and 22 inches above the ground.

- Variation in lead angles do not have a marked effect on vehicle-pedestrian interactions. However, there appears to be a slight trend toward knocking the pedestrian forward (rather than rotating onto the hood) as lead angles increase, i.e., a flatter, blunter profile.

- For child pedestrians, there is a decreasing tendency to be rotated onto the hood as the contact occurs farther and farther above the hip. For adult pedestrians, the tendency to be rotated onto the hood increases as the contact occurs farther below the hip.

- At higher impact speeds, the pedestrians tend to rotate onto the hood; as impact speeds decrease, the pedestrian contacts the hood/hood front and is thrown to the pavement. At still lower impact speeds, the pedestrian is knocked to the pavement.

- Adult pedestrians generally are struck by vehicles traveling faster than those that struck children.

- Impact speed accounts for about one-third of the variance in injury severity. There is more variability in injury severity prediction for children than for adults. It is thought that this reflects the influence of pedestrian size: most adults are struck at or below the hip by the vehicle "face" area; small children may be contacted by this area from the head down to the legs while larger children may be contacted from the chest area down.

- The vehicle-pedestrian interaction accounts for approximately 21 percent of the variance in the impact speed variable. While the pedestrian kinematics are affected somewhat by the frontal geometry of the striking vehicle, it appears that the most important factor in the resulting trajectory is the impact speed.

- The results of European research indicate that lead angles under 70° were involved for nearly all leg fractures caused by bumpers. In these data, only 28 percent of fractures occur with lead angles less than 70°. The impact speed appears to be more closely related to the occurrence of lower leg fractures: the average impact speed of accidents involving fractures is 21.5 MPH.

- The pedestrian height and impact speed variables demonstrate substantial differences in their average values for those who contact the windshield and those who do not. The pedestrian group with no windshield contact contains a large number of child pedestrians who rarely contacted vehicle components near the windshield. It is notable that the pedestrians who did strike the windshield area are as short as four feet tall to as tall as six foot four inches; essentially, no portion of the adult population is immune from the risks of windshield contacts.

- The vehicle geometry plays a role secondary to speed in the pedestrian injury generation process.

Vehicle Body Style, Injury and Vehicle-Pedestrian Interactions

- Vans and pickups produce more life-threatening or fatal injuries (AIS 5, 6) among adults than do cars. For children, vans produce more of these injuries than cars or pickups. A larger proportion of head and neck injuries is associated with vans and pickups than with cars. Car impacts result in a larger proportion of injuries to the lower extremities than to other body areas.

- In frontal impacts, children or adults are most often thrown forward or knocked to the pavement by all vehicle types. Because of their small size, children are rarely rotated onto the hoods of cars; never onto this area of vans or pickups. Adults are frequently rotated onto the hoods of cars (21.6%) and pickups (9.8%).

- The avoidance maneuver most often attempted by drivers is to apply the brakes. When brakes are applied, pedestrians are more likely to be thrown forward or knocked to the pavement than when they are not. When brakes are not applied, the pedestrian is more likely to be rotated onto the hood and carried by the vehicle or even rotated over the vehicle top. Due to their higher speeds, non-braking vehicles produced more AIS 5-6 injuries than did braking vehicles (23.2 and 6.6 percent, respectively). There was relatively little difference in the source of injury whether brakes were applied or not.

- Pedestrian orientation with respect to the vehicle -- side to vehicle, facing vehicle -- had relatively little influence on either vehicle-pedestrian interactions or on injury severity.

Injury Source and Severity

- Adults are frequently struck and carried by a vehicle in frontal impacts and children are not. This size-related effect influences the injury experience of both. Adults sustain more serious injuries than children and receive a larger proportion of their injuries from contact with the vehicle than do children. For both children and adults, the majority of injuries to the head, neck, face, and upper and lower extremities are caused by the pavement. For children, the hood face is the source of the highest proportion of all chest injuries; for adults, it is the hood top. Abdomen injuries are most often caused by the hood face for children and by the grille/headlight or hood face for adults. Pelvic-hip injuries are most often caused by the hood face for adults. Pelvic-hip injuries are caused nearly equally by the front bumper and grille/headlight area for children and by the grille/headlight or hood face for adults.

- The pavement ranks first and the bumper second as the source of most lower extremity injuries to children. Most injuries from the pavement consist of abrasions and contusions. The bumper produces fractures only to the lower leg. Among adults, the front bumper most often causes knee and lower leg injuries, the hood face and grille/headlight area cause pelvic-hip injuries, the grille/headlight, front bumper and hood face cause thigh injuries and the pavement causes ankle injuries. Leg fractures are more common among adults than among children.

- In frontal impacts, the bumper is the source of 85.1 percent of children's leg fractures and 69.0 percent of adults' leg fractures. Most remaining leg fractures among children result from the tires or wheels or from energy transfer. For adults, most remaining fractures result from contact with the grille/

headlight area, the hood face, the front fender and energy transfer. Virtually all leg fractures to children and adults occur at impact speeds of over 5 MPH; 76.3 percent of children, and 87.6 percent of adults, sustain these injuries at speeds above 10 MPH.

- The head or neck sustains most life-threatening or fatal injuries (AIS 5, 6) for both children and adults (74.0 and 51.4 percent, respectively). The chest and abdomen are the only other areas to sustain AIS 5, 6 injuries, but with much lower frequency.

- In frontal impacts, the pavement is most frequently the source of head or neck AIS 5,6 injuries with 28.6 for children and 26.2 for adults. Energy transfer ranks second with 21.4 percent for children and 18.4 percent for adults. The hood top, fender and windshield area produce more AIS 5,6 injuries to adults than to children while the hood face and tires or wheels produce more of these injuries to children.

- Children receive 73.3 percent of their head or neck AIS 5,6 injuries at calculated impact speeds of 16-30 MPH; adults receive 40 percent of the same injuries at these speeds and 52 percent at higher speeds.

- For children, 80.8 percent of head or neck AIS 5,6 injuries are associated with the pedestrian being thrown forward by the vehicle; for adults, 43.6 percent of these injuries occur when the pedestrian is thrown forward and another 43.6 percent when the pedestrian is carried by the vehicle or rotated over the top of the vehicle.

Fatal and Non-Fatal Frontal Impacts

- The proportion of fatal accidents increases as car size increases.

- The fatal accident is a higher speed event than the non-fatal accident: 90 percent of the calculated impact speeds for fatal accidents were over 15 MPH; 16 percent of the non-fatal accidents occurred at speeds over 15 MPH.

- The lower extremities are injured more frequently than any other body area in non-fatal accidents. Among the fatalities, head, chest, abdomen and lower extremities (in that order) are most frequently and seriously injured.

- The major sources of injury in non-fatal accidents involving all automobile types are the pavement, bumper face, hood top and hood face. In fatal accidents, the hood top and face and other forward vehicle components increase in frequency of occurrence. The highest AIS in fatal accidents is most often associated with forward vehicle components such as the hood face and top and with energy transfer. Although the pavement produces many injuries among the fatalities, it is less often associated with the highest AIS than is the vehicle front structure.

- In fatal accidents, the front area of subcompacts and compacts extending from the hood edge rearward to the windshield and header are the source of injury more frequently than for larger cars. The implication, with the increasing number of small cars, is that these vehicle components will play an increasingly important role in the future.

- In fatal accidents involving the front of the vehicle, the sheetmetal area of the vehicle extending rearward from the hood face is often the source of major injuries. "Hard" areas such as the hood or fender edge, the bumper and their underlying structures are frequently associated with the more severe pedestrian injuries. Elimination or modification of these components through redesign, or energy absorption, would have a pronounced effect on life-threatening injuries.

- In non-fatal accidents, the predominant injury type involves the lower extremities. The majority of these injuries are associated with the bumper. In fact, about 70 percent of lower extremity fractures are associated with bumper contact. Improvement in this area would significantly reduce the non-minor and disabling injuries now observed in non-fatal accidents.

Side Impacts

- Approximately 20 percent of all the pedestrian accidents involve side impacts and these accidents are far less severe than frontal impacts. AIS 5-6 injuries represent 1.3 percent of the highest AIS ratings for children and 10.9 percent for adults. Clinical analysis of the data indicates that the majority of pedestrians walked into the side of the vehicle and generally were rotated away, falling to the pavement. Serious injuries occur when the vehicle skids laterally and strikes the pedestrian, or when the upper part of the body moves in front of the A-pillar/windshield area as the pedestrian wraps over the fender and hood. The head and torso then are struck by these components.

Costs and Long Term Disability Associated with Pedestrian Accidents

- A detailed cost analysis of the study data was not within the scope of the program contract. Some indication of the costs and of the long term disability, hospital stay, etc. problem was required, however. Study data were collected from 1977 to 1980; while societal costs are based on 1975 dollars, the data readily available for use. Thus, the overall cost derived somewhat underestimates the extent of the problem. The cost portion of this report therefore should be used with caution.

- Using the weighted data (5,089 accidents), total costs were estimated to be close to $70,000,000, or an average of approximately $15,000 per accident. Based on an estimated 110,000 accidents annually, the total cost to society is on the order of $1.7 billion dollars.

- Long term disability was infrequent at AIS levels 1 and 2, and increased to 20, 36 and 100 percent of the pedestrians, respectively, for AIS 3, 4 and 5.

- About 30 percent of pedestrians required hospital treatment. Length of hospital stay was under 10 days for about 60 percent of those requiring treatment, 11-20 days for about 15 percent, 3 to 6 weeks for another 17 percent, and upwards of 6 weeks for the remaining 7 percent.

Base Rate Data

- In general, there were only minor variations between the base rate data and those data collected by the PICS teams. The most significant of these was that the observed data were skewed so that there were more younger pedestrians in the Pedestrian Accident Data Base than in the general accident population.

- A second difference was found for pedestrian actions in the base rate data as compared to the PICS data. This was primarily attributed to difficulties in precisely matching the detailed PICS data with the more general police categories.

- Lastly, there was a slight variation in the distributions of accident types. It was suggested that this was caused by differences in the definitions of applicable cases; accidents included in the Pedestrian Accident Data Base could not involve parking lots and driveways while the base rate data contained those types of cases.

- It is concluded that the PICS data base is quite representative of the population it was intended to sample.

Conclusions

- Frontal impacts represent the most frequent and most hazardous accident types.

- Lower extremity injuries occur most frequently and often involve fractures.

- The head and neck area sustain the majority of life threatening and fatal injuries.

- The threshold for fatal injuries lies in the 11-15 MPH range; the majority occur above 25 MPH.

- Eighty-three percent of non-fatal injuries occurred below 16 MPH.

- The pavement is the source of 40 percent of all injuries and 30 percent of the most serious injuries.

- The frequency of fatality increases as vehicle size increases.

Recommendations

- Training should be provided when any multi-team program of data collection is initiated in the future. This would improve inter-team consistency in investigation and coding of data.

- Performance standards should be developed to assure that vehicles meet appropriate criteria for pedestrian protection. Pedestrians are often seriously injured at relatively low speeds, 10 to 25 MPH.

- The lower extremities are the body areas most frequently injured for both children and adults. Many of these injuries are fractures and lacerations caused by the front bumper or by the hood or fender edge, or when the pedestrian is thrown forward by the vehicle. A resilient or "soft" energy absorbing front end could mitigate these injuries and might also reduce the frequency with which pedestrians are thrown forward by the vehicle.

- The majority of life-threatening and fatal injuries involved the head or neck and were most frequently caused by vehicle components in frontal impacts. It is believed that these injuries could also be reduced by "soft" front area because the pedestrian's progress along the hood toward the windshield would be impeded as his leg and pelvic area sank into the front end. This will become an increasingly important factor as car size continues to decrease and a broader range of pedestrians will be able to reach the cowl and windshield area. In this regard the underhood, cowl and windshield area also should be designed to reduce the hazard to pedestrians.

1. INTRODUCTION

The objectives of the Data Analysis phase of the Pedestrian Injury Causation Study (PICS) were as follows:

- To identify those factors in pedestrian/motor vehicle accidents that are indicated statistically to be important in causing pedestrian injury severity.

- To identify relationships between pedestrians, their injuries, and motor vehicle design.

- To identify relationships between pedestrians, their injuries, and direct costs associated with pedestrian/motor vehicle accidents.

- To examine the feasibility of determining injury severity distribution and costs (within the jurisdictions of the study), utilizing relations and correlations between police collectable data and more detailed accident investigations.

Data were collected by five teams located in the cities of Buffalo, Palo Alto, Los Angeles, San Antonio, and Washington, D.C. The participating teams (see Page 3) collected a sample of police-reported pedestrian accidents over a period of two and one-half years. Only those accidents involving automobiles, pickup trucks, and vans were collected. The sampling criteria included: 100% of fatal accidents and a systematic random sample of all other pedestrian accidents such that each team collected a total (fatal and other combined) of 450 accidents. (Dynamic Science and BioTechnology started later than the other teams and the goal for each was 350 cases.) Dynamic Science sampled fatal accidents at the same rate as non-fatal, rather than investigating 100% because of the large number of pedestrian cases in Los Angeles. The total cases collected involved 1,997 accidents, 2,021 vehicles and 2,068 pedestrians.

Data collection included obtaining the report prepared by investigating police, examination of the involved vehicle, contacting the driver, pedestrian and any witnesses, inspecting and documenting the scene of the accident, and obtaining a medical report on those pedestrians who were injured and treated at a medical facility. The investigation included photographs and measurement of exterior damage and other marks on the vehicle, and of the accident scene, in order that impact speed and the relationship between vehicle design features and injury could be determined.

The exterior of the automobile was inspected for pedestrian contact points, relevant vehicle damage and to obtain the vehicle identification number (VIN). Human data involved questions on vehicle maneuvers, driver actions, pedestrian height, weight, number of doctor visits, number of days off work and actions taken prior to impact. Medical information included the pedestrian's specific injuries, length of hospital stay, and requirements for special treatment (e.g., surgery, or radiology).

This report describes the data collected, the quality control procedures, the data file and the data analysis.

2. STUDY DATA

2.1 Data Source

Study data were collected over a thirty-month period in 1977-1980 by five contractors in different parts of the United States, as shown below in Table 2-1.

TABLE 2-1. - PARTICIPANTS IN PEDESTRIAN ACCIDENT DATA COLLECTION

Contractor	Area Sampled	Number of Accidents in File	Dates of Collection Period
Calspan Field Services, Inc. (CFSI)	Buffalo, NY and three surround-areas	450	August 1, 1977 - February 14, 1980
Southwest Research Institute (SWRI)	San Antonio, TX	431	August 29, 1977 - February 21, 1980
Dynamic Science, Inc. (DSI)	Selected Precincts, Los Angeles, CA	331	March 15, 1978 - March 3, 1980
BioTechnology (BT)	Washington, D.C.	340	April 9, 1978 - December 29, 1979
Traffic Safety Research Corporation (TSRC)	San Jose, CA and surrounding areas	445	August 8, 1977 - February 25, 1980
TOTAL CASES		1,997	

The specifics of the data collection phase, i.e., sampling schemes, investigation procedures, etc. for individual teams are described in References 1-5. These data collection reports also discuss the methodology utilized to insure that the data maintained a high degree of accuracy, the internal case review procedures and any problems experienced.

This volume is initiated with a detailed description of the data collection and quality control procedures, the Pedestrian Accident Data Base and the procedures used to generate it. This is followed by a section devoted to the determination of the various weighting factors that were applied to the individual observations (also see Appendix 1). The results of the data analysis phase of the PICS project are presented. The environmental and pre-crash conditions/behaviors are discussed and, subsequent to this, a description of the impact and post-impact phase is provided. This includes a major section devoted to the factors affecting the pedestrian's injury severity. A number of specific issues concerning the pedestrian accidents and pedestrian protection are then addressed. The final section considers the costs of pedestrian accidents.

2.2 Quality Control

Quality control procedures for this program as well as report forms and a Coding Manual were developed by CFSI and reviewed by NHTSA, consistent with the requirements of the original work statement. Quality control procedures encompassed two basic areas: first, periodic on-site visits to the teams to review operating procedures, case data coding and accident reconstruction to ensure that data were collected in a uniform and consistent manner and, second, case review, correction, computer editing and data processing were conducted at CFSI to produce a computer file of the PICS data. Data file documentation is provided in Reference 6.

Data collection criteria are listed below. Cases were checked to assure that these criteria were met as they were reviewed by CFSI. In general, an effort was made to collect data which might have some utility in terms of vehicle design and countermeasures development. Applicable vehicles were limited to automobiles, pickup trucks, and vans.

Data Collection Criteria

Applicable pedestrian accident - A police reported accident in which one or more persons standing, walking, etc. (see Pedestrian definition) in a highway, street or other trafficway is struck by an automobile, pickup truck or van. The driver's intentions are not relevant. The case is applicable even if the driver intentionally strikes the pedestrian, providing that other study criteria are met.

Police Report - A police report must be initiated at the accident scene, i.e., the police must have investigated the accident on scene.

Injury - All fatal accidents falling within the study area are to be collected (except DSI, which sampled). A fatal accident is one in which death occurs within 30 days. Other injury or non-injury accidents are to be collected in accordance with the team sampling plan to achieve the total case volume of 450 (or 350) cases for each team.

Secondary Impacts - Accidents in which the vehicle contacts another vehicle before hitting the pedestrian are excluded.

Hit and Run - These accidents are included only if the vehicle is traced from the scene within 24 hours and there is evidence of the contact remaining on the vehicle. It is assumed that such evidence may be in the form of scratches, dents or other damage since the vehicle would very likely be cleaned to avoid detection. If scene and vehicle evidence are good, the investigator may accept a case that is older than 24 hours, at his discretion. All fatal hit and run accidents should be reported, submitting the available data -- police report, medical, etc.

Definitions:

Pedestrian - A person standing, walking, running, crouching, bending, sitting, roller skating or using a skateboard in a highway, street or other trafficway. Street vendors pushing carts, wagons, etc. are also acceptable. Accidents that involve more than one pedestrian, whether the pedestrians are in close proximity, are considered a single accident. Not acceptable are: persons lying in road, creeping, bicycling, sitting on walls, chairs or other objects, or riding on sleds or similar objects.

Applicable Vehicle - Automobiles, pickup trucks and vans. Not acceptable are: utility vehicles, carryalls, motor homes, trailers of any type, large delivery vans, trucks, buses, motorcycles, mopeds, etc.

Highway, Street - That portion of the road which is intended for vehicular travel. Accidents which occur on the shoulder, sidewalk or curb are included if the vehicle leaves the roadway. Roadways within a large shopping mall, as well as entrances and exits to such malls, also are acceptable sites. Not acceptable are: private driveways, parking lots, gas stations, drive-in window lanes, etc.

2.2.1 Pedestrian Study Case Report Format

The complete Pedestrian Study Case Report consists of a police report, an Administrative Data Form, four types of field data collection forms -- Environment, Vehicle, Human, and Human: Medical Data Supplement -- and a brief descriptive Case Summary Report which describes the accident in concise terms and contains two photographs of the vehicle damage and a sketch illustrating pedestrian injuries. A set of photographs of the vehicle damage and of the scene (8 to 12 photographs) also are part of the case (Appendix 2).

The report forms were developed by CFSI and NHTSA personnel and, because of the desire for detailed information, are quite lengthy. Copies of the forms used (and listed below) appear in Appendix 3.

The report forms were color-keyed as indicated for easy selection of the correct form in the field (an important consideration) and contain an identifying letter in the upper right hand corner. The report forms and other material are listed below in the sequence in which they were arranged for submission by individual teams.

Identification		Number of Pages	Color Key
-	Case Summary Report	5	White
-	Typical Police Report	-	White
A	Administrative Data Form	1	White
E	Environmental Data Form	4	Green
V	Vehicle Data Form(s)	8	Yellow
H	Human Data Form(s)	10	Blue
H1	Human: Medical Data, Supplement(s)	2	Blue
-	Case Photographs	-	-

One copy of the Case Summary Report, the Administrative Data Form, and the Environmental Data Form was required for each case. One Vehicle Data Form was required for each vehicle which contacted a pedestrian without a prior impact with another vehicle. Pages one, two (Total Damage section only) and five of the Vehicle Form were required for each involved vehicle which did not contact a pedestrian. One Human Data Form was required for each pedestrian, driver or witness to the accident. One Human: Medical Data Supplement was required for each pedestrian transported to a hospital or other treatment facility. All of the above data except the Case Summary, the Police Report and the photographs have been placed in a data file described in Section 2.3.

During the last year of data collection, two additional report forms were added by NHTSA (Appendix 3). One of these was entitled "Pedestrian Behavior-Urban Intersection Accidents" and the other, "Pedestrian Behavior-Children". Both forms were directed toward specific pedestrian activities prior to impact. One form was required for urban intersection accidents; the other for accidents involving children. Data from these forms do not appear in the computer file.

2.2.2 Data Flow

Calspan developed appropriate data control procedures for this program. The data processing procedures and data flow are shown in Figure 2-1.

Upon receipt of cases from the team, data processing was initiated with a registration procedure. Case receipt was logged, the submitting team identified, and other pertinent data recorded. Case completeness then was checked in terms of the specific input data items required, i.e., case report forms, medical report, photographs and other data items agreed upon. If items were missing, follow-up was initiated to obtain them. If all of the data for an individual case was available, quality control procedures continued.

When the data for an individual case were available, the case was ready for coding. The actual coding was performed by two people. For economy reasons, the routine coding was performed by experienced clerical personnel. For data requiring more technical knowledge and judgment in coding, an investigator with appropriate experience was used. At this point, all key variables were checked and a clerical (or manual) edit performed.

Next, the codes were keypunched and verified on punched card equipment. Finally, all cards from each case were collated to produce a complete case. While to this point the data were processed with care, the potential for some error remained. These errors could derive from either misjudgments leading up to the coding, coding errors, or keypunch errors which were not discovered and corrected in the verifying process.

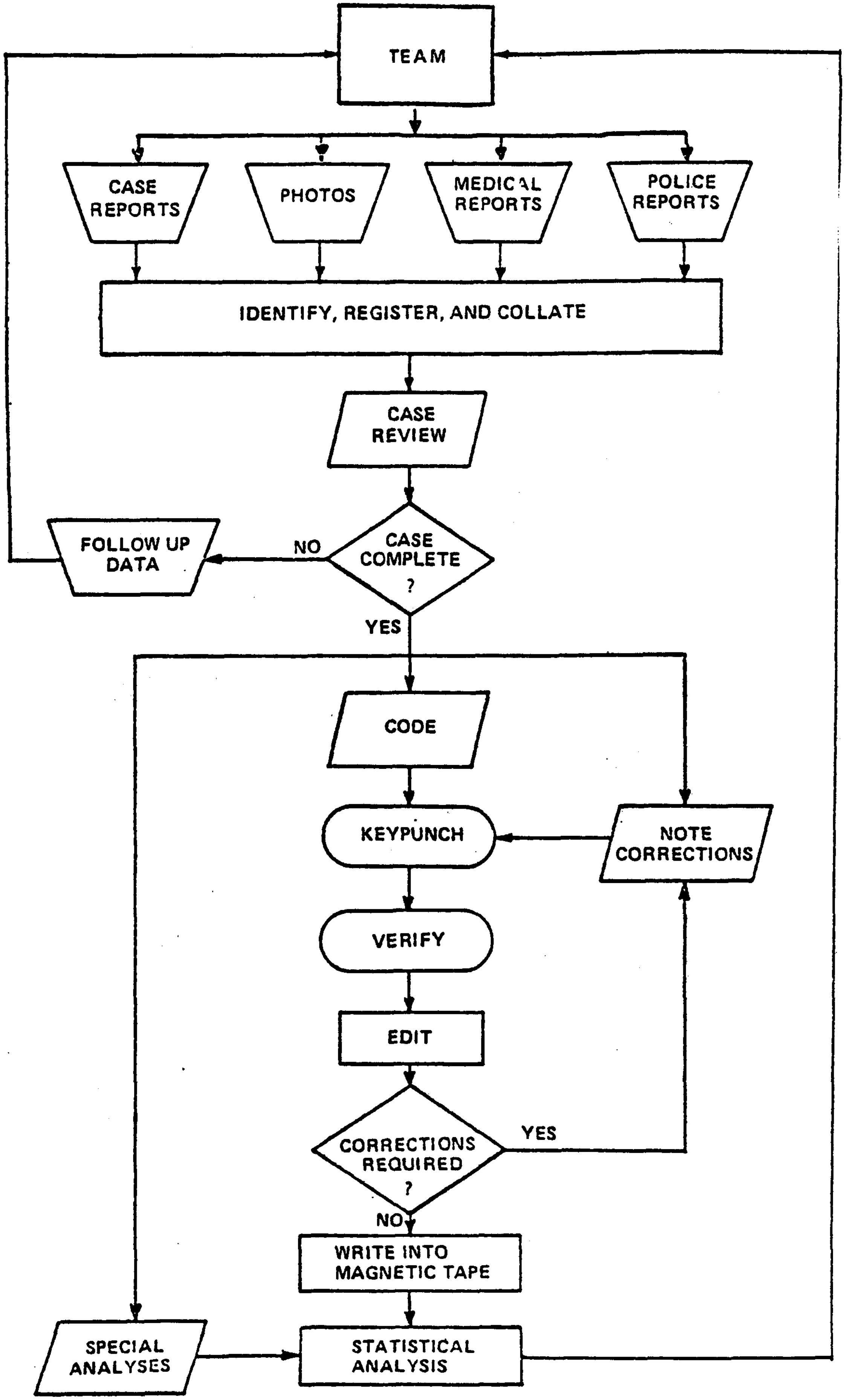


FIGURE 2-1. DATA HANDLING AND QUALITY CONTROL

Hence, at this point, the cards were processed through a computer edit program. This program had three basic functions. First, it examined the cards in each case to ensure that all required cards were present and in the proper sequence. Second, it checked each variable to ensure that the coded values were within legitimate range. Third, comparisons were made among the variables to ensure consistency. If any of these checks was violated, a message was printed defining the problem; the case analyst then referred back to the original case data and made the necessary corrections. The cards were then resubmitted to the edit program until all problems had been resolved.

2.2.3 Input Description (Data Forms)

As noted earlier, Calspan designed all data forms required for data collection and processing effort, coordinating this task with the other teams and with the CTM. As shown in Figure 2-1, the available data consisted of a case report form, photographs, medical report and a police report.

In addition to the data listed, all police reported pedestrian accident data from the study were collected and processed. The formats and procedures required for this task were established and a separate data file was constructed to represent the total pedestrian accident problem for the sampled areas. This "Base Rate Data" is discussed in Appendix 4.

Data Control and Editing Procedures

In any data collection quality control system, it is desirable to begin at the data source and to complete the checking process with the finished product ready for data analysis. In the PICS study, where a random sample of police cases was collected, several checks were required. First, the sampling fraction collected was compared with the police data source (Base

Rate Data) to determine if it was correct. Second, the sampling procedure employed was checked in order to ensure that all collection personnel understood and adhered to the sample design plan. The objective, of course, was to determine whether the number of missing cases was excessive and whether the planned sample of pedestrian accidents was obtained.

An outline of the quality control procedures which were used in the PICS study, appears in Figure 2-2. The data source check (1) was discussed previously. Check number 2 utilized the Case Report Forms. The case was first examined to ensure (a) that all required report forms were present and (b) that all form variables to be checked were recorded. Codes were then checked (c) to ensure that only valid ("legal") codes appeared. Finally, (d) inter-code agreement or consistency was checked, e.g., a minor laceration cannot be rated a 5, or serious injury on the Abbreviated Injury Scale (AIS) (Reference 7).

FIGURE 2-2. QUALITY CONTROL PROCEDURES

1. Data Source vs Data Collected	a) Missing cases b) Adherence to sample design
2. Case Report Forms	a) Case completeness - all forms submitted b) Case completeness - all variables recorded c) Validity - only listed (acceptable) codes recorded d) Consistency - inter-code agreement
3. Case Report Forms vs Photographs, Medical Data, etc.	a) Accuracy - correct coding b) Consistency - code agreement with source data
4. Punched cards and/or Magnetic Tape	Verify data recorded

Available for review were the case photographs, the medical report forms, rough scene sketch with impact point, vehicle and pedestrian rest positions, vehicle path, and tire mark measurements and the pedestrian-vehicle contact data. These forms provided the means for checking the major study variables such as vehicle damage, impact speed, and the injury severity data. A complete check for consistency of vehicle damage, pedestrian kinematics and impact speed requires the field data mentioned. Validity of injury coding could not be checked using the AIS ratings alone; the injury descriptors from the hospital records were needed.

The fourth check involved transfer of the data to punched cards. Here, one person punched the card data and another verified to avoid introducing new errors. During this study, checks 2b, c and d were performed by computer. Other checks were performed by appropriately qualified personnel, and not by machine. (See Figure 2-2.)

2.2.4 Key Variables

The objective of the Pedestrian Injury Causation Study was to identify factors causing pedestrian injury severity and their relationship to both vehicle design and direct costs associated with these accidents in a sample of motor vehicle accidents. Thus, data that accurately defined accident events and vehicle contact points so that accident reconstruction could be accomplished were essential. Related pedestrian injury, and contacts with the vehicle exterior or ground that resulted in injury, also are key variables. Other key variables include vehicle descriptors, vehicle weight and size, vehicle damage measurements, impact speed, and accident type. For the environment, point of impact, rest positions of vehicles, vehicle rotation, and related measurements are important. For the pedestrian, age, height, overall AIS and body area injuries, vehicle contact points causing injury, and relevant medical data are key factors. All key variables were checked by an experienced accident investigator.

2.3 Data File Description

The edited pedestrian accident data were incorporated into a data storage and retrieval system in order to make the data more amenable for detailed data analysis. Specifically, the Statistical Analysis System (SAS) (Reference 8), was used to generate the Pedestrian Accident Data Base (PADB). The SAS system was selected because it provided both the necessary data handling capability and a convenient means for utilizing a wide range of statistical techniques.

Since the structure of a given case varied as a function of the number of vehicles and pedestrians involved, one would have to allow for a data record sufficiently large to handle a two vehicle/three pedestrian accident. In fact, however, experience showed that most accidents were single vehicle/single pedestrian accidents; thus, much of the resulting data file would be wasted space. This would result in increased costs associated with disk storage, as well as in processing the data file. In order to circumvent this problem, the PADB was subdivided into five separate data files. The individual files and their general contents are given below in Table 2-2. A variable by variable listing of each data set is presented in Appendix 1.

The fact that the information from each case is divided into five files does not preclude the analyst from restructuring the data into a "case form." SAS has a provision whereby two or more data sets can be merged (or interleaved) into a single data file. Each record in the five files comprising the PADB has a unique case number which serves as an index to control the merging of files.

TABLE 2-2. - DESCRIPTION OF THE DATA FILES WITHIN THE PEDESTRIAN ACCIDENT DATA BASE

File Name	Contents
ACC [Accident]	Administrative data, Number of involved "units", Alcohol Involvement, Environmental and Scene Data
VEH [Vehicle]	Vehicle and Driver Descriptions and Collision Deformation Classification (CDC)
ACCSEQ [Accident Sequence]	Pre-Impact Activity and Orientation (Pedestrian and Vehicle), Chronological Contact Sequence, Post-Impact Behavior/ Trajectory, and Pedestrian/Vehicle Interaction
HUMAN	Pedestrian Description (Height, Weight, Age), Injury Description, and Treatment and Restrictions
CONTACT	Vehicle damage and the component struck for each pedestrian contact recorded (generally more than one per accident)

The generation of the PADB required two processing procedures. The first invoked a FORTRAN program which pre-processed the data into a form compatible for the SAS procedures which were involved in the second step. As a result of the first task, the FORTRAN pre-processor, six temporary disk files were created--five input files for each of the five data files and a sixth described below. The SAS program then converted each input file into a sorted SAS file; all files were sorted (as a minimum), by case number; the VEH file by vehicle number; the HUMAN file by pedestrian number; and the ACCSEQ and CONTACT files by pedestrian number within vehicle number.

The capability to update the existing PADB was included in the process described above. The sixth data file output by the FORTRAN program contained the case numbers (i.e., team, year, month, and sequence number) of the cases the user desired to have deleted from the data file. The SAS program subsequently sorted the "Delete" file and deleted the appropriate cases from the data base prior to any other processing. The update capability was further enhanced by the ability to change several variable values in an existing case without having to delete and resubmit the case. A third input file to the FORTRAN program contained the "update" cards. The information was channeled to the temporary data set associated with the appropriate SAS data file. The SAS program would then change only those non-blank items of the input for the case being updated.

A flow chart of the PADB generation/update procedure is provided in Figure 2-3.

While the file structure just described is the most efficient way to store the PADB, it is not necessarily the most effective form with which to conduct a large scale data analysis. When the analyst desires to combine the information on two or more of the files, they must first be merged. This merging is a relatively expensive procedure in terms of computer resources. In order to avoid doing this each time, common combinations of the data sets can be merged and stored on magnetic tape. The following "intermediate" data files were generated for this project.

- ACC-HUMAN
- VEH-HUMAN
- ACCSEQ-HUMAN
- CONTACT-HUMAN
- VEH-CONTACT
- VEH-HUMAN-CONTACT

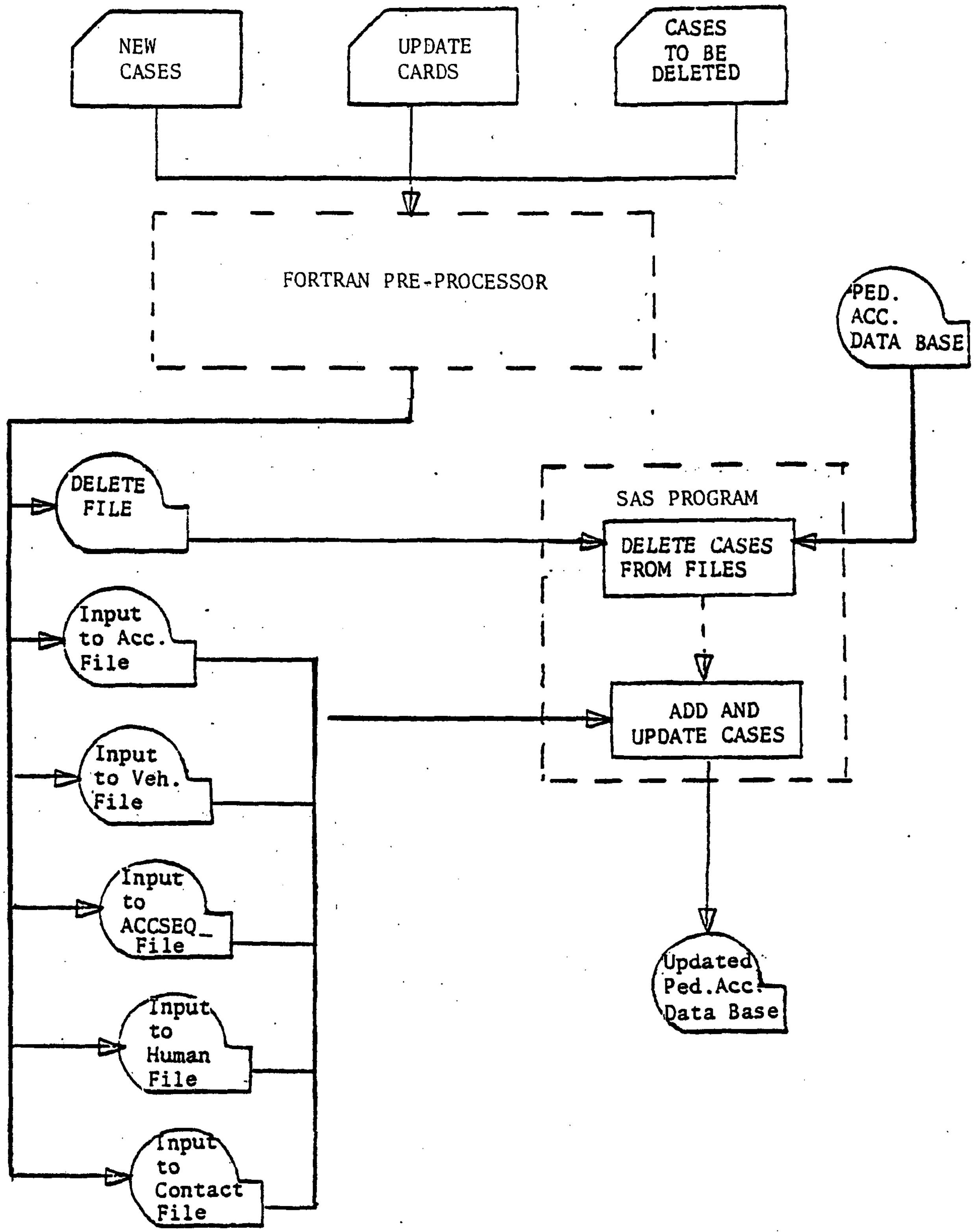


FIGURE 2-3. PEDESTRIAN ACCIDENT DATA BASE GENERATION/UPDATE FLOW CHART

2.4 Case Weighting

In order to make effective use of their resources, the data collection teams had to develop a means for efficiently selecting applicable cases. Such a plan had to satisfy two objectives: (1) to obtain as many pedestrian accidents as possible in the shortest period of time and (2) to document all the different types of pedestrian accidents. Thus, the PADB had to contain not only accidents occurring during peak hours (which would satisfy the primary objective), but also those on weekends, nights, and mornings (low volume events). To this end, the teams developed sampling plans, based on data from Police Annual Reports, which would incorporate both of these objectives.

During the study, each team revised their sampling schemes at least once so that an adequate volume of cases could be realized. Changes generally became necessary as a result of peculiarities in the data used to develop the original plans. For example, one team had to readjust its schedule after it was discovered that a significant number of pedestrian accidents cited in the City annual accident tabulations were not investigated on scene by the police (the basis for the sampling plan was intended to be cases reported on scene) but were reported a day or two later by the victim. In addition, a number of bicycle accidents were included with the pedestrian accidents in the Police Annual report.

In any event, compensation for the case sampling was a necessary facet of the PICS data analysis. Without any adjustment for sampling; i.e., weighting, no estimates of frequencies of occurrence in the overall accident population could be made. Furthermore, data from one or more data collection areas (or across sampling plans in a given area) could not be combined or compared.

Computation of the weighting factor was, for most sampling plans, straightforward. With one exception, each data collection team collected all fatal accidents that occurred; thus, their weighting factor was 1.0. Weights in non-fatal cases (and fatals investigated by the team mentioned above) were based directly on the teams' sampling plans. There were, however, situations which created problems. The most common circumstance involved a cyclical sampling plan which terminated (due to a revision) part way through a cycle. In this case, the weights were not computed on the basis of the planned sampling fraction; rather, the determination was made from the actual number of sampled periods, relative to the number of these periods available, while the sample plan was in operation. Examples of a few of these problem areas are discussed briefly below.

1. The second sampling plan employed by Calspan presented some problems in computing weights. This particular scheme divided the sampling area into three zones.

- A core area comprised of eight police precincts within the City of Buffalo.
- Towns of Amherst and Tonawanda, the Village of Kenmore, and two City of Buffalo police precincts (Area I).
- Town of Cheektowaga and four City of Buffalo police precincts (Area II).

Two data collection areas, from which data were obtained on alternate weeks, were then defined: (1) the core area and Area I, and (2) the core area and

Area II. When attempting to assign weighting factors to pedestrian accidents occurring in the City of Buffalo, it was found that the Jurisdiction Code variable did not distinguish among the different precincts. Without the precinct information, it cannot be determined whether the accident occurred in an area which was sampled each week or every other week.

The method used to circumvent the above problem essentially entailed computing a composite weighting factor for the City of Buffalo (Reference 9). The specifics of it are based on both historical pedestrian accident data and census data. The latter measure was accepted from work performed by the Contract Technical Manager which had shown good correlation between a locality's population and the number of pedestrian accidents. Table 2-3 gives a breakdown of the pedestrian accident frequency for the Buffalo precincts.

TABLE 2-3. - 1976 CITY OF BUFFALO PEDESTRIAN ACCIDENTS

Precincts	N	%
Core Area (Precincts 3, 4, 5, 6, 8, 10, 12, and 16)	475	68
Area I (Precincts 13 and 17)	90	13
Area II (Precincts 7, 9, 11, and 15)	134	19
TOTAL	699	100

The population for the three segments of Buffalo were determined as well. It should be noted that the census tracts and police precincts do not coincide exactly. The results are shown in Table 2-4.

TABLE 2-4. - BREAKDOWN OF BUFFALO POPULATION BY PRECINCTS

Precincts	Population	%
Core Area (Precincts 3, 4, 5, 6, 8, 10, 12, and 16)	280,000	61
Area I (Precincts 13 and 17)	70,000	15
Area II (Precincts 7, 9, 11, and 15)	110,000	24
TOTAL	460,000	100

The proportions from the two tables are relatively consistent, particularly considering that the 1970 census data may not necessarily reflect 1976 Buffalo demographics. Furthermore, the "effective population" of downtown Buffalo, i.e., the core area, may be larger due to the influx of commuters on weekdays.

From the two tables then, the following assumption was made about pedestrian accidents occurring in Buffalo: $\frac{2}{3}$ of them happened in the core area; $\frac{1}{9}$ in Area I; $\frac{2}{9}$ in Area II. The weighting factor for a Buffalo accident was subsequently calculated using the equation:

$$WF = \frac{2}{3}\, WF_{\text{Core Area}} + \frac{1}{9}\, WF_{\text{Area I}} + \frac{2}{9}\, WF_{\text{Area II}}$$

Note that this is <u>not</u> the same as obtaining a composite sampling fraction and computing a weighting factor from it.

2. A second problem involved the second and third sampling plans used by another team. Their plan essentially consisted of a twenty-day cycle, which, in turn, was made up of four five-day segments. The modification that was made to the second sampling plan involved only the elimination of the two least "productive" precincts in the sampling area. However, the second phase lasted for 83 days which, obviously, did not allow for the completion of the fifth twenty-day cycle insofar as the eliminated precincts were concerned. Since the third sampling plan started with the last seventeen days of the cycle, the rest of the sampling area was not affected. The difference in the sampling fractions for the dropped and retained areas are given in Table 2-5.

TABLE 2-5. - EFFECTS OF SHORTENED SAMPLING CYCLE

Sampling Time	Areas Retained in Third Sample Period	Areas Dropped in Third Sample Period
0500 - 1700	5.0	4.9
1700 - 2300	2.5	2.4
2300 - 0500	5.0	5.2

It was believed that these differences were not sufficient to warrant further consideration, particularly in view of the fact that the two dropped precincts produced, on average, only three pedestrian accidents per month.

3. The final problem encountered in calculating the sampling weights involved accidents which occurred at the beginning or the end of a shift. With one exception, the sampling intervals for the teams overlapped. For example, one interval would be defined as 0700 to 1500 and a second as being 1500 to 2300. Thus, when assigning the weighting factors, one could not precisely determine in which sampling interval the case belonged without reconstructing the entire sampling scheme. It was felt that the expense of such an effort could not be justified.

A SAS program, which added the weighting factors to the cases in the PADB, was developed at the NHTSA and latter revised by CFSI. A listing of the program is provided in Appendix 1. The individual weighting factors that were applied to the data are presented in Table 2-6 for the various conditions and sampling plans.

The computations for each of the sampling weights is given in Appendix 1.

TABLE 2-6. - SAMPLING WEIGHTS USED IN PEDESTRIAN ACCIDENT DATA BASE FOR NON-FATAL ACCIDENTS

Sampling Plan	Condition: Days	Condition: Time	Condition: Area	Weighting Factor
Calspan I	-	1300 - 2100	-	3.8
(August 1, 1977 to	-	0700 - 1300	-	30.7
9 PM October 31, 1977)	-	2100 - 0400	Area I	30.7
	-	2100 - 0400	Area II	46.0
Calspan II	Mon - Fri	0000 - 0700	Buffalo	7.1
(9 PM October 31, 1977	Mon - Fri	0000 - 0700	Tonawanda	10.3
to March 31, 1979)	Mon - Fri	0000 - 0700	Cheektowaga	10.9
	Mon - Fri	0700 - 1300	Buffalo	7.5
	Mon - Fri	0700 - 1300	Tonawanda	10.9
	Mon - Fri	0700 - 1300	Cheektowaga	11.5
	Mon - Fri	1300 - 1500	Buffalo	1.4
	Mon - Fri	1300 - 1500	Tonawanda	2.1
	Mon - Fri	1300 - 1500	Cheektowaga	2.2
	Mon - Fri	1500 - 2100	Buffalo	1.8
	Mon - Fri	1500 - 2100	Tonawanda	2.6
	Mon - Fri	1500 - 2100	Cheektowaga	2.7
	Sun - Thurs	2100 - 2400	Buffalo	7.1
	Sun - Thurs	2100 - 2400	Tonawanda	10.3
	Sun - Thurs	2100 - 2400	Cheektowaga	10.9
	Sat, Sun	1300 - 2100	Buffalo	5.8
	Sat, Sun	1300 - 2100	Tonawanda	8.6
	Sat, Sun	1300 - 2100	Cheektowaga	8.6
Calspan III	Mon - Fri	0000 - 0400	-	2.6
(April 1, 1979 to	Mon - Fri	0400 - 0700	-	2.1
February 14, 1980)	Mon - Fri	0700 - 1300	-	1.8
	Mon - Fri	1300 - 1500	-	1.1
	Mon - Fri	1500 - 2100	-	1.2
	Mon - Fri	2100 - 2300	-	2.1
	Mon - Fri	2300 - 2400	-	2.6
	Sat, Sun	0000 - 0400	-	1.8
	Sat, Sun	0400 - 1300	-	2.3
	Sat, Sun	1300 - 2100	-	1.5
	Sat, Sun	2100 - 2300	-	2.3
	Sat, Sun	2300 - 2400	-	1.8

TABLE 2-6. - CONTINUED

Sampling Plan	Condition			Weighting Factor
	Days	Time	Area	
Southwest Research I (August 29, 1977 to January 15, 1978)	Mon - Fri	0700 - 1300	-	4.0
	Mon - Fri	1300 - 1900	-	2.0
	Mon - Fri	0000 - 0700	-	5.0
	Mon - Fri	1900 - 2400	-	5.0
	Sat, Sun	All Times	-	5.0
Southwest Research II (January 16, 1978 to October 14, 1979)	Mon - Fri	0000 - 0700	-	5.0
	Mon - Fri	1900 - 2400	-	5.0
	Mon - Fri	0700 - 1900	-	1.7
	Sat, Sun	0100 - 1900	-	4.9
	Sat, Sun	0000 - 0100	-	5.1
	Sat, Sun	1900 - 2400	-	5.1
Southwest Research III (October 15, 1979 to February 21, 1980)	Mon - Fri	0700 - 1900	-	1.0
	Mon - Fri	0000 - 0700	-	4.9
	Mon - Fri	1900 - 2400	-	4.9
	Sat, Sun	All Times	-	5.1
Dynamic Science I (March 15, 1978 to March 9, 1979)	All Days	All Times	-	5.0
Dynamic Science II (March 10, 1979 to May 31, 1979)	All Days	All Times	-	
	-	0500 - 1100	-	5.0
	-	1700 - 2300	-	2.5
		1100 - 1700	-	5.0
	-	2300 - 0500	-	5.0
Dynamic Science III (June 1, 1979 to March 3, 1980)	Same as Dynamic Science II; two police precincts dropped from sampling area.			
Traffic Safety Research I (August 8, 1977 to January 15, 1978)	Sunday	1200 - 2000	-	3.0
	Sun, Sat	0000 - 0400	-	5.1
	Mon - Sat	1200 - 2000	-	1.3
	Mon - Sat	0800 - 1200	-	2.7
	Mon - Sat	2000 - 2200	-	2.7
	Fri, Sat	2200 - 2400	-	5.1

TABLE 2-6. - CONTINUED

Sampling Plan	Condition			Weighting Factor
	Days	Time	Area	
Traffic Safety Research II (January 16, 1978 to February 25, 1980)	Sunday	1200 - 2000	-	3.0
	Sun, Sat	0000 - 0400	-	5.1
	Mon - Sat	1200 - 2000	-	1.3
	Mon - Sat	0700 - 1200	-	2.7
	Mon - Sat	2000 - 2200	-	2.7
	Fri, Sat	2200 - 2400	-	5.1
BioTechnology I (April 9, 1978 to April 14, 1979)	All Days	2300 - 0700	-	13.2
	-	0700 - 1500	-	4.4
	-	1500 - 2300	-	4.4
BioTechnology II (April 15, 1979 to December 29, 1979)	Mon - Fri	1300 - 2100	-	2.0
	Mon - Fri	0000 - 1299	-	4.6
	Mon - Fri	2100 - 2400	-	4.6
	Sat, Sun	All Times	-	4.6

3. PEDESTRIAN ACCIDENTS - AN OVERVIEW

3.1 Introduction

This section provides an overview of the pedestrian accident problem and a comparison of weighted and unweighted data frequencies. The study data were collected by five data collection teams over a period of approximately two and one-half years. The volume of data obtained from each of the teams naturally varied as a function of the sampling plan, the data collection area and the magnitude of the individual team's involvement in the study. Table 3-1 presents the number of cases (both the weighted and unweighted values) that each team investigated. The data from each team are further sub-divided in terms of the sampling plan which was in effect when the pedestrian accident occurred.

Examination of Table 3-1 indicates that there are differences in the relative contributions of the various teams depending on whether unweighted or weighted frequencies are used. A goodness of fit X^2 test is, in fact, significant (X_4^2 = 727.7) and the coefficient of contingency, ϕ', has a value of .4, which indicates a relatively large difference between the two distributions.* Throughout this study, a coefficient of contingency below 0.2 is regarded as not significant, between 0.2 and 0.29 is marginal and a value of 0.3 or greater indicates a significant difference.

*Please note that this application of the X^2 comparison test is somewhat unorthodox in a strict statistical sense, but it helps provide a better understanding of the differences that may or may not exist between the two distributions. The coefficient of contingency, calculated by $(X^2 \div N)^{1/2}$, can have a value ranging from 0 (equivalent distributions) to $\sqrt{1-P/p}$ (all observations in a single cell that has expected probability P) where P is the smallest expected probability.

TABLE 3-1. - CASELOAD BY INVESTIGATING TEAM

Team	Sampling Plan	Actual Cases Investigated	Percent of Total	Weighted Cases Investigated	Percent of Total
Calspan	Phase I	23	1.2	109	2.1
	Phase II	211	10.6	523	10.3
	Phase III	216	10.8	293	5.8
CALSPAN TOTAL		450	22.6	925	18.2
SWRI	Phase I	57	2.9	137	2.7
	Phase II	299	15.0	624	12.3
	Phase III	76	3.8	120	2.4
SWRI TOTAL		432	21.7	881	17.3
Dynamic Science	Phase I	155	7.8	768	15.1
	Phases II & III	176	8.8	660	13.0
DYNAMIC SCIENCE TOTAL		331	16.6	1,428	28.1
TSR	Phases I & II	445	22.3	720	14.1
TSR TOTAL		445	22.3	720	14.1
BioTechnology	Phase I	153	7.7	635	12.5
	Phase II	186	9.3	500	9.8
BIOTECHNOLOGY TOTAL		339	17.0	1,135	22.3
TOTAL		1,997	100.0	5,089	100.0

The remainder of this section of the report is devoted to examining the distribution of certain variables to determine and demonstrate weighted/unweighted differences. The distributions of relevant pedestrian accident variables are used for this purpose and to provide an overview of study data. For convenience, the data have been separated into three categories: accident conditions, characteristics of the drivers, pedestrians and vehicles and severity factors. Each of these categories and the variables within them has a related total, i.e., there were 1,997 pedestrian accidents, 2,021 vehicles were involved in these accidents, 2,068 pedestrians were struck and the number of individual interactions or accident sequences between the vehicles and pedestrians totaled 2,092.

3.2 Accident Conditions

In general, the conditions which were present before and during a pedestrian accident remained relatively constant, with and without weighting the data. It should be noted at the outset, however, that the issue of whether the data were representative of each team's respective area, cannot be answered by comparing weighted and unweighted distributions; rather, comparisons must be made between the weighted frequency distributions and the base rate data. This is addressed in Appendix 4.

3.2.1 Time of Occurrence

Table 3-2 is a tabulation of the weighted and unweighted frequencies of the month in which the accident occurred. The two distributions appear to be similar, and a X^2 statistic shows that the effect of weighting the data is small (X^2_{11} = 25.3, $p \leq 0.01$; ϕ' = 0.07).

TABLE 3-2. - ACCIDENT FREQUENCY BY MONTH (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Month	N	%	N	%
January	165	8.3	395	7.8
February	146	7.3	372	7.3
March	145	7.3	409	8.0
April	162	8.1	442	8.7
May	179	9.0	464	9.1
June	135	6.8	328	6.4
July	115	5.6	313	6.2
August	150	7.5	366	7.2
September	184	9.2	523	10.3
October	204	10.2	504	9.9
November	199	10.0	469	9.2
December	213	10.7	503	9.9
TOTAL	1,997	100.0	5,088*	100.0

*Because the SAS program rounds off the weighted frequencies, the total number of weighted observations will vary slightly from table to table.

The data show little effect of weighting with respect to the day and time of day that the pedestrian accident took place. Tables 3-3 and 3-4 give the frequency distributions for the day and the time of day, respectively. While X^2 statistics are significant in both of these tables, the coefficients of contingency are low (indicating similar distributions) in both cases. For the day of the week variable, a X^2_6 of 83.2 and ϕ' of .13 are obtained; $X^2_5 = 153.7$ and $\phi' = .17$ for the time of day.

TABLE 3-3. - DAY OF WEEK (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Day	N	%	N	%
Sunday	145	7.3	499	9.8
Monday	276	13.8	734	14.4
Tuesday	331	16.6	780	15.3
Wednesday	302	15.1	719	14.1
Thursday	334	16.7	738	14.5
Friday	394	19.7	979	19.2
Saturday	215	10.8	639	12.6
TOTAL	1,997	100.0	5,088	100.0

TABLE 3-4. - TIME OF DAY (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Time of Day	N	%	N	%
0000 - 0359	46	2.3	142	2.8
0400 - 0759	122	6.1	402	7.9
0800 - 1159	189	9.5	669	13.1
1200 - 1559	649	32.5	1,544	30.3
1600 - 1959	823	41.2	1,837	36.1
2000 - 2359	168	8.4	495	9.7
TOTAL	1,997	100.0	5,089	100.0

3.2.2 Accident Descriptors

Few variations were noted in the variables which provide a means of categorizing a pedestrian accident. The vast majority (95.6%) of accidents collected involved one vehicle and one pedestrian. There was so little difference in the weighted distributions that they are omitted. Table 3-5 gives the joint distribution of the number of pedestrians and vehicles involved.

TABLE 3-5. - JOINT DISTRIBUTION OF NUMBER OF INVOLVED UNITS

Number of Vehicles	Number of Pedestrians 1	2	3	Total
1	1,909	58	6	1,973
2	23	1	0	24
TOTAL	1,932	59	6	1,997

There are two variables contained in the data base which together give a good description of the accident. The first, accident type, describes what occurred just prior to the impact. The coding for this variable is complex, and an explanation of the various accident types is given in Figure 3-1 (Reference 10). The vehicle/pedestrian interaction provides a qualitative description of what happened to the pedestrian during the impact phase of the accident. The frequency distributions are presented in Tables 3-6 and 3-7. The unknown categories have been deleted from the tabulations.

A X^2 goodness-of-fit test did detect a significant difference between the two accident type distributions but the coefficient of contingency is very small ($X_9^2 = 23.7$, $p \leq .005$, $\phi' = 0.07$). It can be seen that in a large majority of pedestrian cases, i.e., almost 82 percent, the pedestrian, apparently unaware of the presence of the striking vehicle, put himself into a hazardous situation; this includes the first five accident types. Note, however, that there is nothing in the description of these accident types which would imply that either the pedestrian or the driver was at fault. Instead, the variable merely describes the actions just prior to impact.

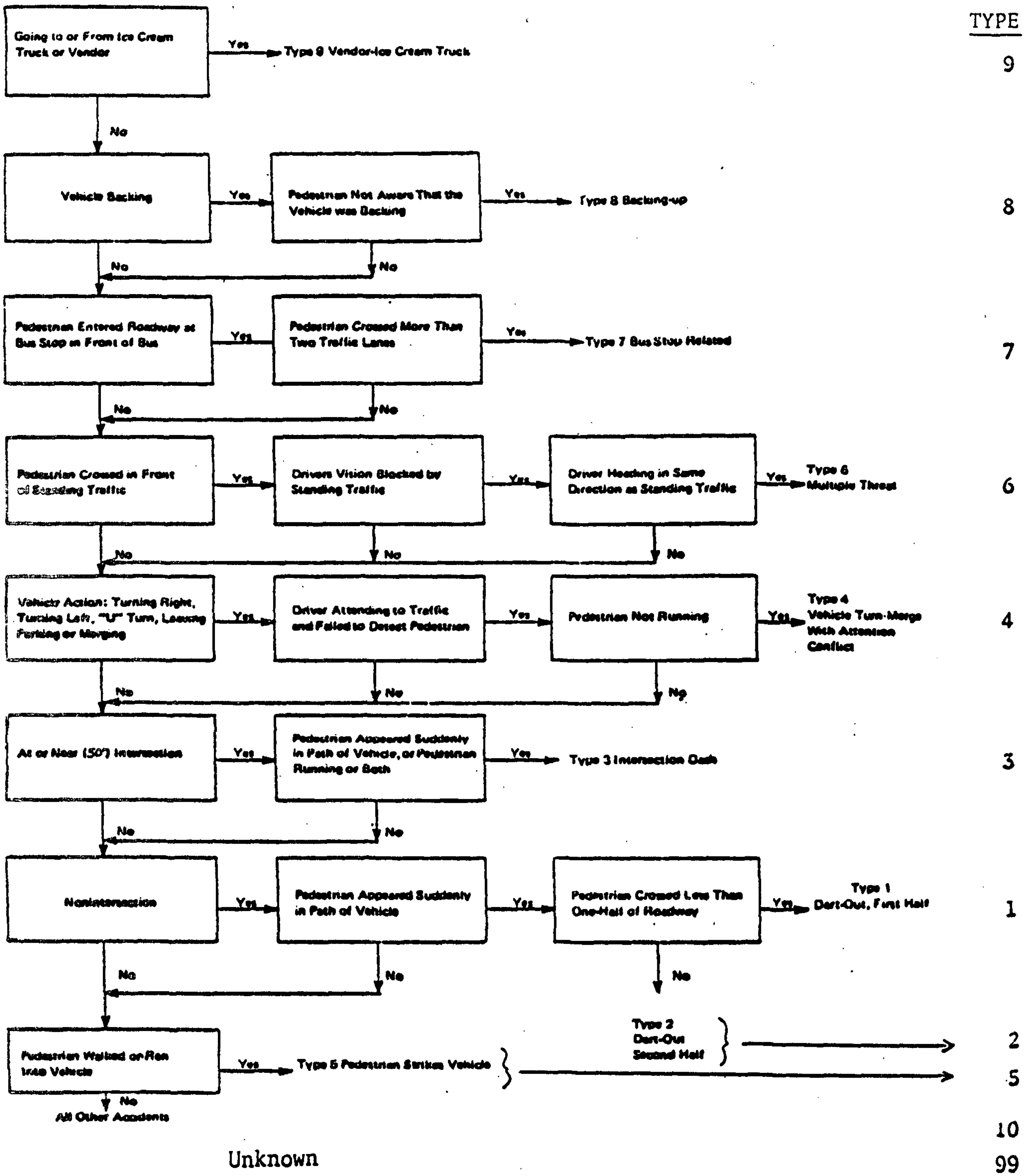


FIGURE 3-1. PEDESTRIAN ACCIDENT TYPES

TABLE 3-6. - UNWEIGHTED AND WEIGHTED ACCIDENT TYPE FREQUENCY DISTRIBUTIONS

	Unweighted		Weighted	
Accident Type	N	%	N	%
Dart Out, First Half	369	18.6	888	17.5
Dart Out, Second Half	239	12.1	624	12.3
Intersection Dash	475	24.0	1,171	23.1
Vehicle Turn-Merge with Attention Conflict	229	11.5	665	13.1
Pedestrian Strikes Vehicle	311	15.7	802	15.8
Multiple Threat	105	5.3	286	5.6
Bus Stop Related	12	0.6	30	0.6
Backing-Up	32	1.6	98	1.9
Vendor-Ice Cream Truck	36	1.8	79	1.6
Other	175	8.8	428	8.4
TOTAL	1,983	100.0	5,071	100.0

TABLE 3-7. - UNWEIGHTED AND WEIGHTED VEHICLE-PEDESTRIAN INTERACTION

Vehicle-Pedestrian Interaction	Unweighted N	Unweighted %	Weighted N	Weighted %
Frontal Impact				
Carried by vehicle	56	2.9	135	2.8
Carried by vehicle, wrapped position	44	2.3	91	1.9
Carried by vehicle, slid to windshield	87	4.5	180	3.7
Rotated over top	24	1.2	39	0.8
Thrown straight forward	226	11.7	539	11.1
Thrown forward and left of vehicle	112	5.8	286	5.9
Thrown forward and right of vehicle	154	8.0	383	7.9
Knocked to pavement, forward	424	22.0	1,160	23.9
Knocked to pavement, left of vehicle	70	3.6	188	3.9
Knocked to pavement, right of vehicle	121	6.3	331	6.8
Knocked to pavement, run over or dragged	43	2.2	69	1.4
Shunted to left (corner impact)	12	0.6	22	0.5
Shunted to right (corner impact)	32	1.7	83	1.7
Other	18	0.9	48	1.0
Unknown	103	---	298	---
Frontal Impact Total	1,526		3,852	
Side Impact				
Knocked to pavement	338	17.6	859	17.7
Bumped or pushed aside	47	2.4	139	2.9
Snagged, rotated	24	1.2	59	1.2
Snagged, dragged by vehicle	3	0.2	8	0.2
Feet or legs run over	46	2.4	108	2.2
Other	9	0.5	24	0.5
Unknown	15	---	51	---
Side Impact Total	482		1,248	
Rear Impact				
Carried by vehicle	0	0	0	0.0
Thrown rearward, straight, right, or left	1	0.1	1	0.0
Knocked to pavement, straight, right, or left	24	1.2	68	1.4
Knocked to pavement, run over or dragged	6	0.3	14	0.3
Shunted, left or right (corner impact)	0	0	0	0.0
Other	4	0.2	10	0.2
Unknown	2	---	10	---
Rear Impact Total	37		103	
Unknown	47	---	111	---
TOTAL	2,092	100.0	5,314	100.0

The term vehicle-pedestrian interaction describes the accident events as they relate to the vehicle and pedestrian. Basically, these interactions are defined in terms of whether the pedestrian was knocked to the pavement, thrown forward or carried by the vehicle. Distance along the vehicle surface -- up to the windshield, over the top -- and the direction that the pedestrian was thrown by the vehicle also are identified.

After combining the "Carried by Vehicle-Rear Impacts" Category with "Thrown Rearward, Straight, Right, or Left" and "Shunted, Left or Right" with "Other-Rear Impact", a X^2 (with 22 degrees of freedom) of 55.53 was computed. While this was significant, the coefficient of contingency was low ($\phi' = .10$), which implies that no practical differences arose from weighting the data.

It can be seen from Table 3-7 that the majority of pedestrian accidents (74%) were frontal (including corner) impacts. Caution is advised in making any further inferences from this table because it is known that other factors affect this variable. For instance, those who were knocked forward onto the pavement (the largest single category) are later seen to be predominantly children. Also, the accidents that were investigated represent "on-road" accidents versus all types of vehicle-pedestrian interactions.

Another way of classifying pedestrian accidents is by impact speed. Two methods of providing impact speed estimates were used. The first, and most reliable estimate, was strictly calculated from scene evidence. As is shown in Table 3-8, this estimate resulted in a large number of vehicles without calculated impact speeds -- on the order of 70%*. Thus, analyses which include impact speed as a factor are somewhat limited, both in terms of generalizability and cell frequency.

---

* The percentages for each category in this table are based on the total less the unknowns. Out of 2,021 vehicles in the PICS file, 1,430 did not have calculated impact speeds.

TABLE 3-8. - CALCULATED IMPACT SPEEDS (UNWEIGHTED AND WEIGHTED)

Impact Speed (MPH)*	Unweighted N	Unweighted %	Weighted N	Weighted %
0	17	2.9	54	3.9
1-5	105	17.8	296	21.6
6-10	192	32.5	449	32.7
11-15	115	19.5	273	19.9
16-20	60	10.2	120	8.7
21-25	40	6.8	84	6.1
26-30	28	4.7	48	3.5
31-35	12	2.0	18	1.3
36-40	4	0.7	5	0.4
41-45	9	1.5	11	0.8
46-50	5	0.8	9	0.7
> 50	4	0.7	5	0.4
TOTAL	591	100.0	1,372	100.0

*First interactions only.

As in many of the other variables discussed, a X^2 goodness-of-fit test is significant, but there is little evidence of any strong effect, i.e., $\phi' = .16$.

The second estimate of impact speed attempted to use data from other sources, notably pedestrian throw distances, eyewitnesses, and an injury/speed curve. The latter source was an empirical curve fitting technique based on the relationship between impact speed and resultant pedestrian injury obtained from cases in which the speed could be calculated. Obviously, the speed estimates thus derived cannot be used in assessing factors which are related to pedestrian injury severity. The described approach was used because the lack of physical evidence limited the number of cases for which impact speed could be calculated.

The sources used for the impact speed estimates, for all vehicle-pedestrian interactions, are given in Table 3-9; only the actual frequencies are provided (also see Section 3.1).

TABLE 3-9. - ACTUAL FREQUENCY OF SOURCES FOR IMPACT SPEED ESTIMATES

Source of Speed Estimate	Frequency	%
Calculated	609	29.1
Throw distance	10	0.5
Eyewitness	591	28.3
Injury/Speed Curve	857	41.0
No estimate made	25	1.2
TOTAL	2,092	100.0

The frequency distribution for the non-calculated impact speeds is presented in Table 3-10. A goodness-of-fit test between the weighted and unweighted frequencies is again statistically significant ($X^2_{11} = 72.7$) but of little practical value ($\phi' = .14$).

TABLE 3-10. NONCALCULATED ESTIMATE OF IMPACT SPEED (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Impact Speed (MPH)*	N	%	N	%
0	12	0.9	29	0.8
1-5	504	35.8	1,472	39.6
6-10	386	27.4	1,085	29.2
11-15	184	13.1	443	11.9
16-20	134	9.5	321	8.6
21-25	76	5.4	179	4.8
26-30	61	4.3	116	3.1
31-35	19	1.3	25	0.7
36-40	14	1.0	23	0.6
41-45	9	0.6	9	0.2
46-50	7	0.5	8	0.2
> 50	2	0.1	2	0.1
N/A, Unknown	1	---	5	---
TOTAL	1,409	100.0	3,717	100.0

*First interactions only.

There are large differences between the frequency tabulations for the calculated and non-calculated impact speed estimates. A X^2 value of 423.9 is obtained with a coefficient of contingency of 0.56. This indicates that the distributions cannot be used interchangeably; hence, the non-calculated speed estimates cannot be used as a surrogate of the calculated speeds to decrease the number of unknown values. This does not mean that the non-calculated estimates are incorrect but, rather, suggests that accidents where tire marks from braking or skidding are present (hence, calculated impact speeds) differ from those where evidence is not present, with respect to speeds and, possibly, other variables. As noted earlier, however, non-calculated speed estimates cannot be used in assessing injury severity but do provide reasonable estimates for grouping accident types, examining the frequency of certain causal factors and other similar uses.

3.2.3 Pedestrian Accident Environment

The data elements which describe the environment in which the pedestrian accident took place are presented in this subsection. As is shown in Table 3-11, the data were collected almost exclusively in urban areas. This was part of the study design, and all of the data collection teams were located in large metropolitan areas, i.e., Buffalo, New York, Los Angeles, California, San Jose, California, San Antonio, Texas, and Washington, D.C. The few rural cases occurred in less developed areas within or near city limits.

TABLE 3-11. - DATA COLLECTION AREA (UNWEIGHTED)

Area of Accident	N	%
Urban	1,958	98.8
Rural	23	1.2
Unknown	16	---
TOTAL	1,997	100.0

As a result, the pedestrian accident data cannot be considered to be representative of the entire United States; instead, the data concentrate on the vicinities in which pedestrian accidents are most prevalent. Thus the following tables are essentially only descriptive of the current data base, or, at best, of the urban pedestrian accident problem.

Table 3-12, which is a compilation of the intersection type, shows that pedestrian accidents are about equally divided between intersections and non-intersections. Throughout this study, an intersection-pedestrian accident is one that occurs within approximately 50 feet of the intersection boundary line.

TABLE 3-12. - FREQUENCY OF OCCURRENCE BY INTERSECTION TYPE (UNWEIGHTED AND WEIGHTED)

Intersection Type	Unweighted N	Unweighted %	Weighted N	Weighted %
None	995	49.8	2,402	47.2
3 Leg "T"	292	14.6	762	15.0
3 Leg "Y"	42	2.1	108	2.1
4 Leg Cross	565	28.3	1,511	29.7
4 Leg Oblique	79	4.0	222	4.4
Multileg	23	1.2	82	1.6
Unknown	1	---	1	---
TOTAL	1,997	100.0	5,088	100.0

Weighting the data, however, has little effect on the relative frequencies (X_5^2 = 19.7; p ≤.005; ø' = 0.06).

Since most of the data collection plans tried to concentrate on the afternoon and early evening hours, it was thought that there might be a bias toward collecting pedestrian accidents which occurred in the daylight. This was not the case (see Table 3-13); a goodness-of-fit test yielded a X^2 of 0.11 (two degrees of freedom), which was not statistically significant.

TABLE 3-13. - LIGHT CONDITIONS (UNWEIGHTED AND WEIGHTED)

Light Condition	Unweighted N	Unweighted %	Weighted N	Weighted %
Daylight	1,363	68.3	3,483	68.4
Dawn or Dusk	120	6.0	308	6.1
Darkness	514	25.7	1,298	25.5
TOTAL	1,997	100.0	5,089	100.0

Table 3-14 provides the unweighted and weighted frequencies of the existing weather conditions at the time of the accident, and Table 3-15 of the corresponding road conditions.

TABLE 3-14. - AMBIENT WEATHER CONDITIONS (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Weather	N	%	N	%
Clear/Dry	1,534	76.9	4,048	79.6
Rain	201	10.1	503	9.9
Snow	27	1.4	57	1.1
Fog	3	0.2	4	0.1
Cloudy/Overcast	231	11.6	471	9.3
Unknown	1	---	5	---
TOTAL	1,997	100.0	5,088	100.0

A X^2 of 35.6 (4 d.f.) is obtained (Table 3-14), which, while statistically significant, does not have much practical significance ($\phi' = 0.08$).

TABLE 3-15. - ROADWAY CONDITION (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Road Condition	N	%	N	%
Dry	1,680	84.1	4,345	85.4
Wet	279	14.0	662	13.0
Snow	29	1.5	51	1.0
Ice	6	0.3	23	0.5
Other	3	0.2	7	0.1
TOTAL	1,997	100.0	5,088	100.0

Again, a statistically significant difference between the weighted and unweighted distributions is detected in Table 3-15 (X_4^2 = 17.9; $p \leq .005$; ϕ' = 0.06), but the coefficient of contingency is sufficiently low so that the effect can be realistically ignored. It should be noted that the winter conditions (snow and ice) in Table 3-14 and 3-15 came primarily from Calspan (Buffalo, New York) cases; there were, however, two instances of snow contributed by BioTechnology (Washington, D.C.).

3.2.4 Pre-Crash Activity

The behavior of the pedestrian was recorded for each pedestrian impact. Similar vehicle related information was collected on a case-by-case basis and for each individual pedestrian impact throughout an accident sequence. Since such a large majority of the accidents involved a single vehicle and a single pedestrian, much of this information will be the same.

In Tables 3-16 and 3-17, it can be seen that the pedestrian accidents collected in this study generally involved a vehicle traveling straight along the road with the driver making no avoidance attempt (perhaps because there was insufficient warning of the impending event) or else, attempting to brake before contacting the pedestrian.

The effect of weighting in Table 3-16 yielded a X^2 value of 28.3 which is statistically significant, however, the coefficient of contingency is small enough (ϕ' = 0.07) to disregard the difference for practical purposes.

The relative proportions of right turns to left turns just prior to pedestrian involvement is noteworthy as well. Almost two and a half times as many drivers were making a left turn, which may be indicative of the fact that they were monitoring oncoming traffic rather than pedestrian activity.

TABLE 3-16. - PRE-IMPACT VEHICLE ACTIVITY
(UNWEIGHTED AND WEIGHTED)

Vehicle Action	Unweighted		Weighted	
	N	%	N	%
Traveling straight	1,598	77.7	3,925	75.2
Right turn	69	3.4	185	3.5
Left turn	169	8.2	484	9.3
Changing lanes	42	2.0	100	1.9
Backing	39	1.9	115	2.2
Starting in roadway	93	4.5	290	5.6
Other driver controlled behavior	38	1.8	95	1.8
Not driver controlled behavior	9	0.4	25	0.5
Other, N/A, or unknown	35	---	97	---
TOTAL	2,092	100.0	5,316	100.0

TABLE 3-17. - ATTEMPTED AVOIDANCE MANEUVER
(UNWEIGHTED AND WEIGHTED)

Maneuver	Unweighted		Weighted	
	N	%	N	%
None	513	27.3	1,348	27.1
Braking	1,032	54.9	2,792	56.2
Steering left	35	1.9	89	1.8
Steering right	9	0.5	31	0.6
Brake, and steer left	182	9.7	438	8.8
Brake, and steer right	105	5.6	254	5.1
Other	5	0.3	14	0.3
N/A, unknown	116	---	349	---
TOTAL	1,997	100.0	5,315	100.0

There is no detectable difference (Table 3-17) after the observed data were weighted in order to adjust for the sampling (X^2_6 = 9.6; NS). It is interesting to note that the majority of the steering inputs were made to the left. This might indicate that the pedestrian appeared to the right of the involved vehicle. This will be discussed below in the context of the pedestrian's behavior.

Table 3-18 provides a record of what the pedestrian was doing just prior to the accident. It is clear that the most prevalent activity was crossing a street with no signal present. (Signals = 20.5 percent, other crossing = 65.9 percent.) Ironically, the proportion of pedestrians crossing with and against a signal was the same. It should be noted that the distribution of pedestrian activities does not vary, from a practical standpoint, as a result of weighting the data (X^2_{11} = 33.6; $p \leq .001$; ϕ' = .08).

TABLE 3-18. - PRE-CRASH PEDESTRIAN ACTIVITY (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Activity	N	%	N	%
Waiting for bus, taxi, light change, etc.	14	0.7	48	0.9
Working on vehicle	9	0.4	31	0.6
Working in roadway	55	2.7	139	2.7
Getting in or out of another vehicle	13	0.6	35	0.7
Crossing with signal	210	10.3	600	11.6
Crossing against signal	207	10.2	570	11.0
Schoolbus related	11	0.5	17	0.3
Other bus related	53	2.6	114	2.2
Crossing between parked vehicles	591	29.0	1,491	28.8
Crossing, no parked vehicle nearby	753	36.9	1,846	35.6
Playing in road	47	2.3	97	1.9
Other	75	3.7	193	3.7
N/A, unknown	54	---	133	---
TOTAL	2,092	100.0	5,314	100.0

Table 3-19 presents the distribution of the accident site variable. This data element is not greatly affected by weighting ($X^2_3 = 65.4$; $p \leq .001$; $\phi' = 0.11$). Note again that about half of the pedestrians were struck at intersections where drivers, presumably, might be expected to exert more care in watching for pedestrians.

TABLE 3-19. - ACCIDENT SITE FREQUENCY DISTRIBUTIONS (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Accident Site	N	%	N	%
Intersection and crosswalk	575	27.5	1,710	32.2
Intersection and no crosswalk	428	20.5	947	17.8
Non-intersection and crosswalk	30	1.4	69	1.3
Non-intersection and no crosswalk	1,057	50.6	2,584	48.7
Other	2	----	6	----
TOTAL	2,092	100.0	5,316	100.0

Tables 3-20 and 3-21 describe the pedestrian's orientation and movement relative to the striking vehicle. Both of these variables indicate that the majority of involved pedestrians were moving approximately perpendicular to the traffic flow (i.e., crossing its path).

TABLE 3-20. - PEDESTRIAN ORIENTATION RELATIVE TO STRIKING VEHICLE PRIOR TO IMPACT

(UNWEIGHTED AND WEIGHTED)

Orientation to Vehicle	Unweighted N	Unweighted %	Weighted N	Weighted %
Facing vehicle	351	17.3	916	17.7
Facing away	86	4.2	181	3.5
Left side toward vehicle	925	45.7	2,361	45.7
Right side toward vehicle	664	32.8	1,710	33.1
Other, N/A, and unknown	66	----	150	----
TOTAL	2,092	100.0	5,318	100.0

From Table 3-20, it can be shown that the practical effect of adjusting the data for sampling was not significant (X_3^2 = 6.7; ϕ' = .04). Assuming that the pedestrian was walking forward, the table implies (as suggested earlier), that the pedestrian entered the striking vehicle's path from the right (as viewed by the vehicle operator).

Table 3-21 is a joint distribution of the vehicular travel direction and the direction the pedestrian was moving. There should be considerable agreement between this table and Table 3-20. If, as assumed above, the pedestrian was primarily walking straight ahead then the correlation should be almost perfect, which it is not. For instance the sum of the cell entries for vehicle heading east - pedestrian west, vehicle heading north - pedestrian south, vehicle heading west - pedestrian east, and vehicle heading south - pedestrian north should equal the frequency for the "facing vehicle" category in Table 3-20. One possible explanation for this disagreement may be the lack of representation of the compound compass directions, i.e., north-west, where a pedestrian or vehicle is not traveling technically "straight ahead". Note that only the unweighted frequencies are given in Table 3-21a and summarized in 3-21b.

TABLE 3-21a. - JOINT DISTRIBUTION OF PEDESTRIAN AND VEHICLE TRAVEL DIRECTIONS

Vehicle Direction	Pedestrian Direction				
	North	East	South	West	TOTAL
North	44	185	23	243	495
East	196	36	175	26	433
South	46	235	32	197	510
West	175	48	283	40	546
TOTAL	461	504	513	506	1,984

TABLE 3-21b. - SUMMARY TABLE OF PEDESTRIAN AND VEHICLE TRAVEL DIRECTIONS

Orientation Toward Vehicle	Composed of: Vehicle Heading	Composed of: Pedestrian Heading	N	%
Facing vehicle	North	South	143	7.2
	East	West		
	South	North		
	West	East		
Facing away	North	North	152	7.7
	East	East		
	South	South		
	West	West		
Left side toward vehicle	North	West	957	48.2
	East	North		
	South	East		
	West	South		
Right side toward vehicle	North	East	732	36.9
	East	South		
	South	West		
	West	North		

Finally, any avoidance maneuver on the part of the pedestrian is examined. A tabulation of the frequencies of the various actions is contained in Table 3-22 for both the weighted and unweighted observations.

TABLE 3-22. - ATTEMPTED PEDESTRIAN AVOIDANCE MANEUVER (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Avoidance Manuever	N	%	N	%
Stopped	55	3.0	152	3.3
Accelerated pace	78	4.3	199	4.3
Ran away (along vehicle path)	10	0.6	22	0.5
Jumped	29	1.6	64	1.4
Turned toward vehicle	73	4.0	175	3.8
Turned away from vehicle	72	4.0	197	4.2
Dove and fell away	4	0.2	7	0.2
Vault corner of vehicle	3	0.2	13	0.3
Vault onto vehicle	6	0.3	18	0.4
Brace against vehicle	166	9.2	450	9.7
Other	24	1.3	72	1.5
Not Applicable	1,294	71.3	3,279	70.5
Unknown	278	---	666	---
TOTAL	2,092	100.0	5,314	100.0

It should be noted that the pedestrians whose actions were classified as "Not Applicable" in Table 3-22, Pedestrian Avoidance Maneuver, were those who did not see the vehicle which struck them in time to attempt to avoid it. This situation was clearly the most frequent. A goodness-of-fit test showed no evidence of differences between the unweighted and weighted distribution, i.e., $X^2_{11} = 12.1$.

3.3 Participants in Pedestrian Accidents

3.3.1 Pedestrian Characteristics

Table 3-23 gives the distribution of the involved pedestrians by sex.

TABLE 3-23. - SEX OF INVOLVED PEDESTRIAN (UNWEIGHTED AND WEIGHTED)

Sex	Unweighted N	Unweighted %	Weighted N	Weighted %
Male	1,216	58.8	3,089	58.8
Female	852	41.2	2,163	41.2
TOTAL	2,068	100.0	5,252	100.0

A X^2 statistic of 0.0005 was obtained in a goodness-of-fit test, which indicates that the variable is relatively unaffected by the weighting of the data. Males tend to be overrepresented in the population of pedestrian accident victims since they represented 48.7 percent of the population in the U.S. according to the 1970 Census.

A significant goodness-of-fit X^2 ($X^2_{17} = 42.5$; $p \leq .001$; $\phi' = 0.09$) was computed for the distributions in Table 3-24, Pedestrian Age, but the coefficient of contingency was sufficiently low so that the effect could be disregarded for practical purposes. It is interesting to note that almost 50% of the pedestrians struck were fifteen years old or younger. The frequency of involvement seems to gradually decrease with age until, after about 40 years old, there is a "leveling off."

TABLE 3-24. - FREQUENCY DISTRIBUTION OF PEDESTRIAN AGE (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Pedestrian Age	N	%	N	%
1-5	294	14.3	762	14.6
6-10	509	24.7	1,234	23.6
11-15	217	10.5	511	9.8
16-20	167	8.1	446	8.5
21-25	120	5.8	339	6.5
26-30	111	5.4	322	6.2
31-35	88	4.3	229	4.4
36-40	54	2.6	170	3.3
41-45	56	2.7	139	2.7
46-50	61	3.0	140	2.7
51-55	61	3.0	171	3.3
56-60	60	2.9	173	3.3
61-65	66	3.2	144	2.8
66-70	57	2.8	132	2.5
71-75	56	2.7	124	2.4
76-80	33	1.6	74	1.4
81-85	35	1.7	77	1.5
≥ 86	17	0.8	33	0.6
Unknown	6	---	30	---
TOTAL	2,068	100.0	5,250	100.0

Tables 3-25 and 3-26 provide the unweighted height and weight characteristics of the different sex and age groups; Table 3-25 provides data for males and Table 3-26 for females.

TABLE 3-25. - HEIGHT AND WEIGHT BY AGE GROUP FOR MALE PEDESTRIANS

		Height			Weight		
Age Group	N	Mean	Std. Dev.	Range	Mean	Std. Dev.	Range
1-5	158	40.4	4.6	33	40.4	9.0	65
6-10	266	50.2	4.6	28	59.6	14.7	90
11-15	102	61.7	5.7	28	105.4	29.8	153
16-20	66	68.0	3.4	17	146.5	23.1	141
21-25	57	68.2	3.5	19	163.0	37.4	240
26-30	49	67.5	3.7	20	156.1	22.3	84
31-35	33	68.5	3.3	18	167.4	25.0	110
36-40	23	67.6	2.9	11	159.0	29.7	142
41-45	25	68.6	3.3	16	179.2	38.0	140
46-50	27	68.5	3.0	11	174.4	28.8	130
51-55	12	64.8	3.2	9	143.8	23.7	87
56-60	32	67.8	3.3	14	166.8	26.8	103
61-65	33	68.0	2.9	13	164.0	30.0	134
66-70	21	65.7	5.2	18	160.3	21.2	90
71-75	17	66.1	3.7	18	157.5	33.0	125
76-80	9	66.2	3.8	11	148.6	43.8	138
81-85	18	66.2	2.9	11	149.1	19.2	58
≥ 86	10	65.7	4.3	13	139.7	32.5	100

TABLE 3-26. - HEIGHT AND WEIGHT BY AGE GROUP
FOR FEMALE PEDESTRIANS

		Height			Weight		
Age Group	N	Mean	Std. Dev.	Range	Mean	Std. Dev.	Range
1-5	83	40.5	4.7	30	36.4	8.0	40
6-10	139	49.9	4.9	35	57.5	14.2	70
11-15	75	61.4	4.1	18	106.1	24.4	153
16-20	67	63.1	3.3	20	126.5	28.9	200
21-25	42	63.8	3.0	12	127.0	24.3	110
26-30	27	63.0	2.3	9	125.3	25.4	90
31-35	29	64.2	3.2	17	136.6	28.0	120
36-40	18	62.6	4.1	17	131.5	19.7	63
41-45	10	63.5	3.4	11	118.4	23.6	78
46-50	17	62.4	2.0	7	136.3	19.9	67
51-55	26	62.7	3.8	17	155.2	29.4	147
56-60	21	63.0	2.2	10	149.8	35.5	132
61-65	20	62.0	3.3	16	128.3	26.0	92
66-70	25	63.3	3.3	13	137.7	22.6	100
71-75	21	61.9	3.3	16	124.0	23.2	82
76-80	11	61.6	2.8	9	135.6	20.4	70
81-85	12	61.6	2.3	7	128.8	22.5	65
≥ 86	3	61.0	1.7	3	116.0	16.4	32

3.3.2 Driver Characteristics

Driver sex and age frequency distributions are presented in Tables 3-27 and 3-28, respectively, for those vehicles which were involved in a pedestrian accident.

TABLE 3-27. - DRIVER SEX IN PEDESTRIAN ACCIDENTS (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Sex	N	%	N	%
Male	1,387	69.9	3,540	69.8
Female	596	30.1	1,534	30.2
Unknown	38	---	34	---
TOTAL	2,021	100.0	5,108	100.0

TABLE 3-28. - AGE OF PEDESTRIAN INVOLVED DRIVERS (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Age	N	%	N	%
11-15	7	0.4	10	0.2
16-20	326	16.4	788	15.5
21-25	382	19.3	928	18.2
26-30	285	14.4	781	15.3
31-35	210	10.6	500	9.8
36-40	164	8.3	420	8.2
41-45	126	6.4	332	6.5
46-50	109	5.5	279	5.5
51-55	93	4.7	262	5.1
56-60	88	4.4	226	4.4
61-65	79	4.0	213	4.2
66-70	52	2.6	176	3.5
71-75	26	1.3	79	1.6
≥ 76	35	1.8	99	1.9
Unknown	39	---	60	---
TOTAL	2,021	100.0	5,153	100.0

Goodness-of-fit tests were performed on both sets of frequency distributions from the tables. With regard to driver sex, no significant effects could be found, $X_1^2 = 0.04$; a X^2 statistic of 37.2 ($p \leq .001$) was obtained for the driver age, but the practical effect is negligible ($\phi' = 0.09$).

There was nothing in the comparison of the unweighted and weighted driver characteristic data that appeared to be remarkable.

3.3.3 Vehicle Characteristics

Table 3-29 gives the distribution of the body style of the striking vehicle with the data weighted and unweighted.

TABLE 3-29. - PEDESTRIAN ACCIDENT INVOLVED VEHICLE BODY STYLE (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Body Style	N	%	N	%
Passenger car	1,554	78.4	4,069	80.3
Stationwagon	153	7.7	352	6.9
Convertible	22	1.1	69	1.4
Car, pickup body	14	0.7	27	0.5
Van-passenger	41	2.1	82	1.6
Van-cargo	43	2.2	98	1.9
Pickup	154	7.8	372	7.3
Other, unknown	40	---	82	---
TOTAL	2,021	100.0	5,151	100.0

The effect of weighting these data is minimal (X^2_6 = 19.8; p $\leq$.005; ϕ' = 0.06). The type of vehicle most frequently involved in pedestrian accidents is, not surprisingly, a passenger car, representing nearly 90 percent of the accident vehicles. It should be noted that regional differences are reflected in this tabulation because most of the pickups were found in San Antonio and Los Angeles. An alternative way to look at the type of striking vehicle is presented in Table 3-30. This uses the model type component in the make/model data element. Note that the vehicle type categories are a reasonable representation of the gross vehicle weight. The vehicle weight alone is not considered to be a particularly relevant variable, since a pedestrian is at a huge disadvantage with even the lightest of vehicles.

TABLE 3-30. - PEDESTRIAN ACCIDENT INVOLVED VEHICLE TYPE (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Vehicle Type	N	%	N	%
Minicar	358	18.6	950	19.2
Compact	390	20.3	1,046	21.2
Intermediate	436	22.7	1,130	22.9
Full size	408	21.2	1,002	20.3
Luxury/Limo	99	5.1	277	5.6
Small van (Econoline)	77	4.0	161	3.3
Pickup	156	8.1	374	7.6
Other/Unknown	97	---	212	---
TOTAL	2,021	100.0	5,152	100.0

Not surprisingly, the effect of weighting the data are the same in this case as was found for the body style: statistically (X^2_6 = 15.9; p $\leq$ .025), but not practically significant (ϕ' = 0.06).

Important characteristics of the striking vehicle are the surfaces that contacted the pedestrian. In frontal impacts, two measures of these surfaces are available: the lead angle and the hood length. The lead angle is derived from the hood height, the bumper height, and the bumper lead. Specifically:

$$\text{Lead Angle} = \text{Tan}^{-1}\left[\frac{\text{Hood Height - Bumper Height}}{\text{Bumper Lead}}\right]$$

The result is, as shown in Figure 3-2, an indication of the bluntness of the striking edge of the contacting vehicle. It is clear from the figure that a front end which is perfectly flat will have a lead angle of 90°. Thus, loading would be distributed across the body area contacted and not concentrated as it would be if the bumper protruded and the lead angle was lower. The distribution of lead angles within the Pedestrian Accident Data Base are given in Table 3-31. Note that only data from frontal accidents are reported.

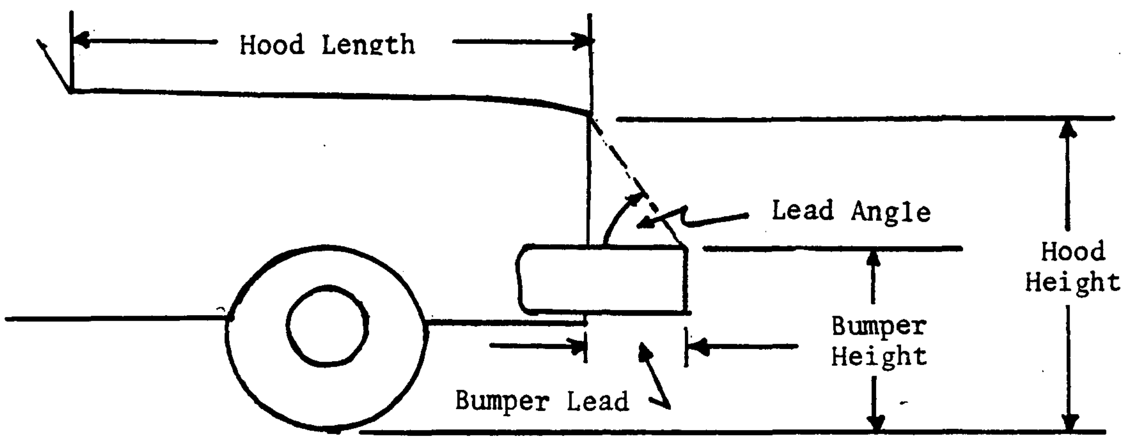


FIGURE 3-2. LEAD ANGLE SCHEMATIC

TABLE 3-31. - LEAD ANGLE FREQUENCY DISTRIBUTION
(UNWEIGHTED AND WEIGHTED)

Lead Angle (degrees)	Unweighted		Weighted	
	N	%	N	%
< 50	9	0.9	23	0.9
50-59.9	40	3.9	79	3.1
60-69.9	264	25.6	713	28.3
70-79.9	489	47.5	1,165	46.3
80-89.9	208	20.2	489	19.4
90	20	1.9	48	1.9
Unknown	490	---	1,339	---
TOTAL	1,520	100.0	3,856	100.0

A statistically, but not practically, significant effect of weighting the data was found for the lead angle data element (X_5^2 = 12.6, $p \leq .05$; ϕ' = 0.07).

The distributions of the hood length of vehicles in frontal pedestrian impacts are given in Table 3-32. Hood length is defined as the distance from the leading edge of the hood to the rear edge.

TABLE 3-32. - DISTRIBUTIONS OF HOOD LENGTH (FRONTAL IMPACTS)
(UNWEIGHTED AND WEIGHTED)

Hood Length (inches)	Unweighted		Weighted	
	N	%	N	%
0-9.9	2	0.2	3	0.1
10-19.9	19	1.9	44	1.8
20-29.9	12	1.2	18	0.7
30-39.9	23	2.3	71	2.9
40-49.9	199	19.6	514	20.8
50-59.9	336	33.2	851	34.5
60-69.9	385	38.0	893	36.2
70-79.9	37	3.7	76	3.1
80-89.9	-	-	- -	-
Unknown	506	---	1,387	---
TOTAL	1,519	100.0	3,857	100.0

The hood length variable, like many others, shows a statistically significant, although not particularly meaningful, difference between its unweighted and weighted distributions ($X_8^2 = 16.9$; $p \leq 0.05$; $\phi' = 0.08$).

In order to further describe the characteristics of the striking vehicle, the observed joint distribution of known lead angles and hood lengths are provided in Table 3-33. As would be expected from the univariate distributions, the most prevalent combination of hood length and lead angle is 70-79 degrees with a hood length from 50-69.9 inches.

TABLE 3-33. - JOINT DISTRIBUTION OF LEAD ANGLE AND HOOD LENGTH

Hood Length (inches)	Lead Angles (Degrees)						
	< 50	50-59.9	60-69.9	70-79.9	80-89.9	90	TOTAL
0-9.9	0	0	0	0	1	0	1
10-19.9	0	0	0	3	14	0	17
20-29.9	0	0	0	2	10	0	12
30-39.9	1	4	11	3	3	0	22
40-49.9	5	8	51	98	31	1	194
50-59.9	2	7	80	160	68	9	326
60-69.9	1	18	101	186	61	9	376
70-79.9	0	2	14	14	6	0	36
80-89.9	0	0	0	0	0	0	0
TOTAL	9	39	257	466	194	19	984

In rear end accidents the parameters which describe the characteristics are rear bumper height and trunk height. These are presented in Table 3-34 and Table 3-35 respectively. Note that there are fewer observations of trunk heights than rear bumper heights; this stems from the fact that not all vehicles with rear bumpers necessarily have trunks, e.g. pickup trucks, vans, and El Camino type automobiles, etc.

TABLE 3-34. - REAR BUMPER HEIGHTS - REAR IMPACTS ONLY (UNWEIGHTED AND WEIGHTED)

Bumper Height (inches)	Unweighted N	Unweighted %	Weighted N	Weighted %
15-20	5	21.7	12	18.8
21-25	13	56.5	32	50.0
26-30	4	17.4	15	23.4
> 30	1	4.3	5	7.8
Unknown	26	---	71	---
TOTAL	49	100.0	135	100.0

TABLE 3-35. - TRUCK HEIGHT FREQUENCY DISTRIBUTIONS (REAR IMPACTS) (UNWEIGHTED AND WEIGHTED)

Trunk Height (Inches)	Unweighted N	Unweighted %	Weighted N	Weighted %
< 20	1	4.8	2	3.6
20-29	1	4.8	1	1.8
30-39	13	61.9	41	73.2
40-49	2	9.5	6	10.7
≥ 50	4	19.0	6	10.7
Unknown	26	---	71	---
TOTAL	47	100.0	127	100.0

The most striking feature of the two tables above is the paucity of rear end pedestrian accidents. In addition, there are no apparent differences caused by weighting (X_3^2 = 3.9 for rear bumper heights; X_4^2 = 4.5 for trunk heights).

The parameter of most interest in side impact involved vehicles is the height at which the maximum vehicle side protrusion occurs. This is tabulated in Table 3-36.

TABLE 3-36. - DISTRIBUTIONS OF THE HEIGHT OF MAXIMUM VEHICLE SIDE PROTRUSION (UNWEIGHTED AND WEIGHTED)

Protrusion Height (Inches)	Unweighted		Weighted	
	N	%	N	%
< 20	7	2.4	18	2.3
20-29	238	81.0	616	79.2
30-39	45	15.3	132	17.0
≥40	4	1.4	12	1.5
Unknown	206	---	495	---
TOTAL	500	100.0	1,273	100.0

Weighting the data does not affect the distributions of the height of the protruding surface, and a goodness-of-fit proved to be not significant, $X_3^2 = 1.9$.

3.4 Pedestrian Injury Severity

The last major aspect of the general pedestrian accident problem is the severity of the injury sustained by the struck pedestrian. Two direct measures of injury severity for each pedestrian are contained within the Pedestrian Accident Data Base; specifically, they are the Abbreviated Injury Scale (AIS) (Reference 7) rating and the Injury Severity Score (ISS) (Reference 11). Both ratings represent an overall or summary assessment of the injuries sustained by the pedestrian. The frequency distributions for overall AIS and ISS are presented in Tables 3-37 and 3-38, respectively. Both unweighted and weighted observations are provided.

TABLE 3-37. - PEDESTRIAN OVERALL INJURY DISTRIBUTIONS (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Overall AIS	N	%	N	%
0 (Uninjured)	20	1.0	54	1.1
1 (Minor)	1,127	58.5	3,134	65.0
2 (Moderate)	298	15.5	692	14.3
3 (Severe, not life threatening)	202	10.5	486	10.1
4 (Serious, life threatening)	112	5.8	244	5.1
5 (Critical, survival uncertain)	110	5.7	153	3.2
6 (Maximum, currently untreatable)	56	2.9	60	1.2
8 (Injured, severity unknown)	138	---	413	---
9 (Unknown if injured)	5	---	16	---
TOTAL	2,068	100.0	5,252	100.0

A X^2 goodness-of-fit test results in a X^2 of 144.5 and a coefficient of contingency of 0.17. These results are statistically significant, however, they are somewhat surprising. In light of the sampling plans even greater differences were anticipated; four of the five teams documented each fatal accident which occurred in their data collection area. On the other hand, the less severe accidents were weighted with a sampling fraction as high as 46. Essentially, the proportions of non-fatals would increase when weighted, while fatal accidents would decrease relative to the rest of the sample. Thus, there is a distinct possibility that these data are affected by the sampling scheme. In particular, the unweighted data appear to contain a higher incidence of the more serious injuries.

The Injury Severity Score was examined next. The ISS is a mathematically derived code number based on the AIS. It is the sum of the squares of the highest AIS codes in each of the three most severely injured body regions. The ISS requires that injuries be categorized by body region.

The AIS result is replicated using the ISS data (shown in Table 3-38). In this case, a X^2 statistic of 138.2 is obtained, which results in a coefficient of contingency of 0.17. It is interesting to note in this regard, that the ISS frequency distribution is not nearly as "well behaved" as the distribution of AIS; once the peak frequency is reached using the AIS, the frequencies decrease monotonically from 1 to 6. This is not the case with the ISS. There are a number of local peaks between the 1-5 ISS range (the most frequent) to the highest values. This may partly stem from the way the data were categorized using intervals with a width of five. Within any interval, not all the scores can be obtained. For instance, in the 21-25 range, there is no combination of injury severities which will yield an ISS of 23.* Depending on the interval selected, the number of possible values in each interval of width five varies.

It should also be pointed out that the mean ISS score, unweighted, is 8.34, while after weighting, it is 5.89. This trend is in agreement with the previous findings.

---

* Twenty-one is obtained from 4-2-1 combination; 22 from 3-3-2; 24 from 4-2-2; and 25 from a 5-0-0.

TABLE 3-38. - INJURY SEVERITY SCORE (ISS) DISTRIBUTIONS (UNWEIGHTED AND WEIGHTED)

ISS	Unweighted N	Unweighted %	Weighted N	Weighted %
0	20	1.0	54	1.1
1-5	1,374	71.4	3,715	77.0
6-10	163	8.5	395	8.2
11-15	56	2.9	134	2.8
16-20	82	4.3	176	3.6
21-25	26	1.4	68	1.4
26-30	41	2.1	65	1.3
31-35	23	1.2	37	0.8
36-40	15	0.8	32	0.7
41-45	32	1.7	41	0.9
46-50	23	1.2	24	0.5
51-55	4	0.2	4	0.1
56-60	25	1.3	33	0.7
≥ 61	41	2.1	45	0.9
Injured, severity unknown	138	---	413	---
Unknown if injured	5	---	16	---
TOTAL	2,068	100.0	5,252	100.0

A second method of examining the pedestrian injury severity is to present the AIS rating for each injury sustained by the pedestrian rather than the overall rating shown in Table 3-37. These data appear in Table 3-39; only the actual observations are given.

TABLE 3-39. - SEVERITY OF EACH PEDESTRIAN INJURY (UNWEIGHTED)

AIS	N	%
0 (None)	0	0.0
1 (Minor)	6,139	73.1
2 (Moderate)	829	9.9
3 (Severe, not life threatening)	689	8.2
4 (Serious, life threatening)	387	4.6
5 (Critical, survival uncertain)	240	2.9
6 (Maximum, currently untreatable)	69	0.8
8 Severity unknown	42	0.5
TOTAL	8,395	100.0

In Table 3-39, there were no instances of an AIS coding of zero (no injury) whereas there were 20 uninjured persons in the overall injury data element (Table 3-37). This is because only the actual injuries are recorded; if none was sustained, then nothing was coded. Note also the increase in the frequency of the less serious injuries, as compared to Table 3-37. This is not surprising, in that pedestrians who are seriously hurt suffer minor injuries as well.

Table 3-40 provides data concerning the type of lesion that comprised the pedestrian's most serious injury. Both the unweighted and weighted frequencies are given.

TABLE 3-40. - FREQUENCY DISTRIBUTIONS OF THE MOST SEVERE PEDESTRIAN LESION (HIGHEST AIS) (UNWEIGHTED AND WEIGHTED)

	Unweighted		Weighted	
Lesion	N	%	N	%
Abrasion	262	13.7	740	15.4
Amputation	3	0.2	3	0.1
Avulsion	4	0.2	7	0.1
Concussion	175	9.1	384	8.0
Contusion	566	29.5	1,467	30.6
Crushing	13	0.7	14	0.3
Dislocation	27	1.4	55	1.1
Fracture	401	20.9	900	18.8
Hemorrhage	10	0.5	14	0.3
Laceration	212	11.1	523	10.9
Pain	176	9.2	516	10.8
Rupture	12	0.6	20	0.4
Sprain	31	1.6	72	1.5
Other	26	1.4	77	1.6
Unknown	28	---	58	---
TOTAL	1,946	100.0	4,850	100.0

While the coefficient of contingency is not sufficiently high (0.12) to accept the premise that the two distributions are meaningfully different, it is interesting to note that the proportions of relatively minor injuries (abrasions, contusions, and pain) all increase after weighting, whereas the more severe lesions, e.g., avulsions, fractures, crushings, etc., all decrease. Again, it appears as if there is a slight tendency for the unweighted data to be biased toward the more severe accidents.

Table 3-41 is a table of all the lesions that were sustained by the pedestrians.

TABLE 3-41. - DISTRIBUTION OF ALL PEDESTRIAN LESIONS (UNWEIGHTED)

Lesion	N	%
Abrasion	2,253	26.9
Amputation	6	0.1
Avulsion	24	0.3
Burn	1	0.0
Concussion	346	4.1
Contusion	2,385	28.5
Crushing	19	0.2
Dislocation	69	0.8
Fracture	1,135	13.6
Hemorrhage	95	1.1
Laceration	975	11.7
Pain	837	10.0
Rupture	49	0.6
Sprain	52	0.6
Other	120	1.4
Unknown	29	---
TOTAL	8,395	100.0

Finally, the source of the most severe injury sustained by each pedestrian is presented in Table 3-42. The most common source of the most severe injury is the pavement onto which the pedestrian is thrown. The next most frequent sources of injury are, not surprisingly, the front bumper assembly, hood, front fenders, grille, and energy transfer. The latter

TABLE 3-42. - SOURCE OF MOST SEVERE PEDESTRIAN INJURY (UNWEIGHTED AND WEIGHTED)

Source	Unweighted N	Unweighted %	Weighted N	Weighted %
Front bumper assembly	337	19.5	879	20.8
Grille, headlights	99	5.7	246	5.8
Hood face	113	6.5	306	7.2
Hood top	115	6.6	258	6.1
Hood cowl, wiper blade mount	4	0.2	7	0.2
Front fender	125	7.2	326	7.7
Radio antenna	1	0.1	1	0.0
Windshield and trim	51	2.9	89	2.1
Roof	3	0.2	3	0.1
A-pillar	7	0.4	17	0.4
B, C, or D-pillar	3	0.2	10	0.2
Siderail	3	0.2	8	0.2
Door and lower side	28	1.6	78	1.8
Rear fender, quarter panel	25	1.4	58	1.4
Tailgate, trunk deck	6	0.3	12	0.3
Rear bumper	10	0.6	23	0.5
Tires, wheel	79	4.6	157	3.7
Undercarriage	6	0.3	10	0.2
Energy Transfer	99	5.7	211	5.0
Accessories, ornaments	45	2.6	115	2.7
Pavement	556	32.1	1,389	32.9
Other pedestrian or vehicle	4	0.2	5	0.1
Other	11	0.6	20	0.5
Unknown	216	---	622	---
TOTAL	1,946	100.0	4,850	100.0

TABLE 3-43. - SOURCES OF ALL PEDESTRIAN INJURIES (UNWEIGHTED)

Source	N	%
Front bumper assembly	1,028	13.7
Grille, headlights	520	6.9
Hood face	453	6.0
Hood top	664	8.8
Hood cowl, wiper blade mounts	24	0.3
Front fender	465	6.2
Radio antenna	14	0.2
Windshield and trim	224	3.0
Roof	20	0.3
A-pillar	22	0.3
B, C, or D-Pillar	10	0.1
Siderail	10	0.1
Door and lower side	110	1.5
Side windows	8	0.1
Rear fender/quarter panel	72	1.0
Tailgate, trunk deck	16	0.2
Rear bumper	21	0.3
Tires and wheels	189	2.5
Undercarriage	53	0.7
Energy Transfer	304	4.0
Accessories, ornaments	125	1.7
Pavement	3,119	41.4
Other pedestrian/vehicle	12	0.2
Environmental Surfaces	38	0.5
Other	4	0.1
Unknown	870	---
TOTAL	8,395	100.0

category refers to a situation in which an injury is sustained, but not as a result of direct contact. For example, a neck injury caused by the whipping action of the pedestrian's head would be recorded as due to energy transfer.

Once again, there are no meaningful differences detected between the weighted and unweighted distributions: (X^2_{22} = 43.0; p $\leq$.005; ϕ' = 0.10).

The distribution of the sources of all pedestrian injuries is given in Table 3-43; this contains only the unweighted frequencies. There is little difference in the sources which are the most prevalent; the pavement is far and away the most frequent, as it was for the most severe injury, followed by the front bumper, grille, hood, fender, and energy transmittal. It is also noted that the most frequent source within the "Accessories, Ornament" category was the side rearview mirror, which accounted for 98 of the 125 times this source was identified.

3.5 Summary

In summary, the points listed below were considered to be particularly significant in this study of pedestrian accidents:

- Accidents primarily involve a single vehicle and a single pedestrian.

- The pedestrian, unaware of the impending danger, enters the path of the striking vehicle, most often from the right hand side of the vehicle.

- A majority (49.8%) of the pedestrian accidents occurred at a location with no intersection and no traffic control device.

- The driver of the striking vehicle usually was driving straight along the roadway just prior to the accident; evasive maneuvers by the driver were generally confined to braking if any maneuver was, in fact, attempted; almost 95% of the known impact speeds were below 30 MPH.

- After being struck by the vehicle (the vehicle front in 74% of the accidents), the pedestrian was eventually thrown or knocked to the pavement.

- Almost half of the struck pedestrians were fifteen years old or younger.

- A pedestrian rarely escapes injury when struck by a vehicle; the median severity of the injury was an AIS 1, or minor. Consequently, a large proportion of the injuries are contusions and abrasions.

- The most prevalent source of pedestrian injury is clearly the pavement. For 30 percent of the cases, the pavement caused the most severe injury and over 40 percent of all injuries can be attributed to pavement contact.

- Other significant sources of injury are: front bumper, grille, hood, and fenders.

It has been demonstrated throughout this section that, in general, adjusting the data for the various sampling plans had little effect on the data. In essence, the conditions leading up to, and the dynamics within, a pedestrian accident do not vary much as a function of their time of occurrence. One notable exception is that weighting the data tended to reduce the relative proportion of severe pedestrian accidents. This is attributed to the sampling plans which were employed; four of the five data collection teams investigated all fatal pedestrian accidents.

4. ACCIDENT DATA ANALYSIS

4.1 Introduction

There is a vast amount of data available for analysis in the Pedestrian Accident Data Base. However, after a detailed preliminary analysis it was decided to analyze a number of specific and relevant factors that will be reported thoroughly, rather than prepare a large compilation of various unrelated multivariate frequency distributions. Actual data rather than weighted data are used in this Section except in the regression analysis of injury versus impact speed since injury severity was affected by weighting.

The most obvious factor affecting pedestrian injury severity according to most of the literature reviewed (References 12 and 13) is the impact speed of the striking vehicle. Although the volume of cases in which it was possible to accurately calculate impact speed was larger than the total number of cases in many comparable studies, it still represented only about one-third of all the cases collected. Therefore, a second impact speed variable also was included in the data file. Its values were based on sources other than scene evidence, i.e., pedestrian throw distance, eyewitness reports, and an empirical injury-speed distribution. (The latter source, of course, cannot be used in investigating factors related to pedestrian injury severity.)

Consequently, the approach used is to examine the calculated impact speed variable initially. If there appears to be an effect, the other data sources are examined to see whether the effect can be generalized to the entire data set.

4.2 Calculated Impact Speed and Injury Severity

Before the effects of other variables are investigated, it would be beneficial to document the degree to which the current data are affected by the impact speed. In this, and other sections of this report, the data are divided into two groups according to the pedestrian age: (1) ten years old or younger, and (2) older than ten years. These age groups were selected primarily to determine how accident factors vary with respect to pedestrian size and also to relate to current accident testing using child dummies (corresponding approximately to a 10 year old child) and adult dummies.

The severity of a given pedestrian accident can be measured by either an Abbreviated Injury Scale (AIS) rating or an Injury Severity Score (ISS) value. The individual distributions of both of these variables are provided in Figures 4-1 and 4-2 for children 10 years old or less and in Figures 4-3 and 4-4 for older pedestrians. Note the regression line in each of these plots. The specifics of the separate regressions are given in Table 4-1.

TABLE 4-1. - PARAMETERS OF INJURY SEVERITY AS A FUNCTION OF IMPACT SPEED

Age Group (Years)	Injury Severity Measure	Intercept	Slope	R^2
≤ 10	AIS	0.65	0.105	.39
≤ 10	ISS	-2.58	0.86	.34
> 10	AIS	0.92	0.088	.41
> 10	ISS	-3.33	0.95	.45

It can be seen in Table 4-1 that, at most, the impact speed variable accounts for about one-third of the variance in child injury severity. At best, in the adult ISS values, the impact speed accounts for almost half of the observed variance in the resultant injury rating. It is also interesting to note the stability in the parameters (particularly in the AIS measures) between the two age groups. There is, of course, more variability in injury severity prediction for children than adults, as evidenced by the larger values of R^2 for adults.

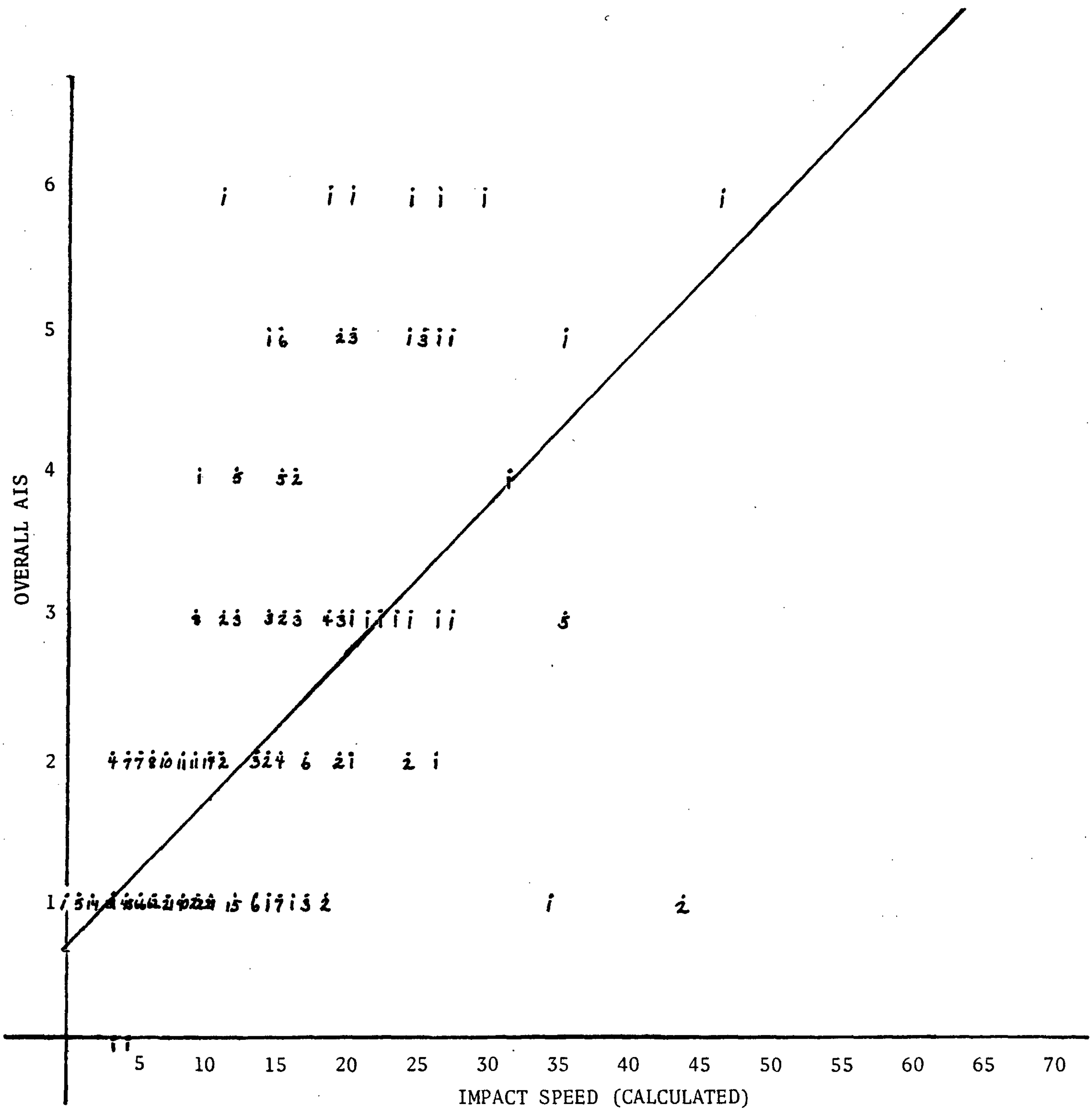


FIGURE 4-1 - OVERALL AIS BY IMPACT SPEED - FRONTAL IMPACTS WEIGHTED
PEDESTRIAN AGE ≤ 10

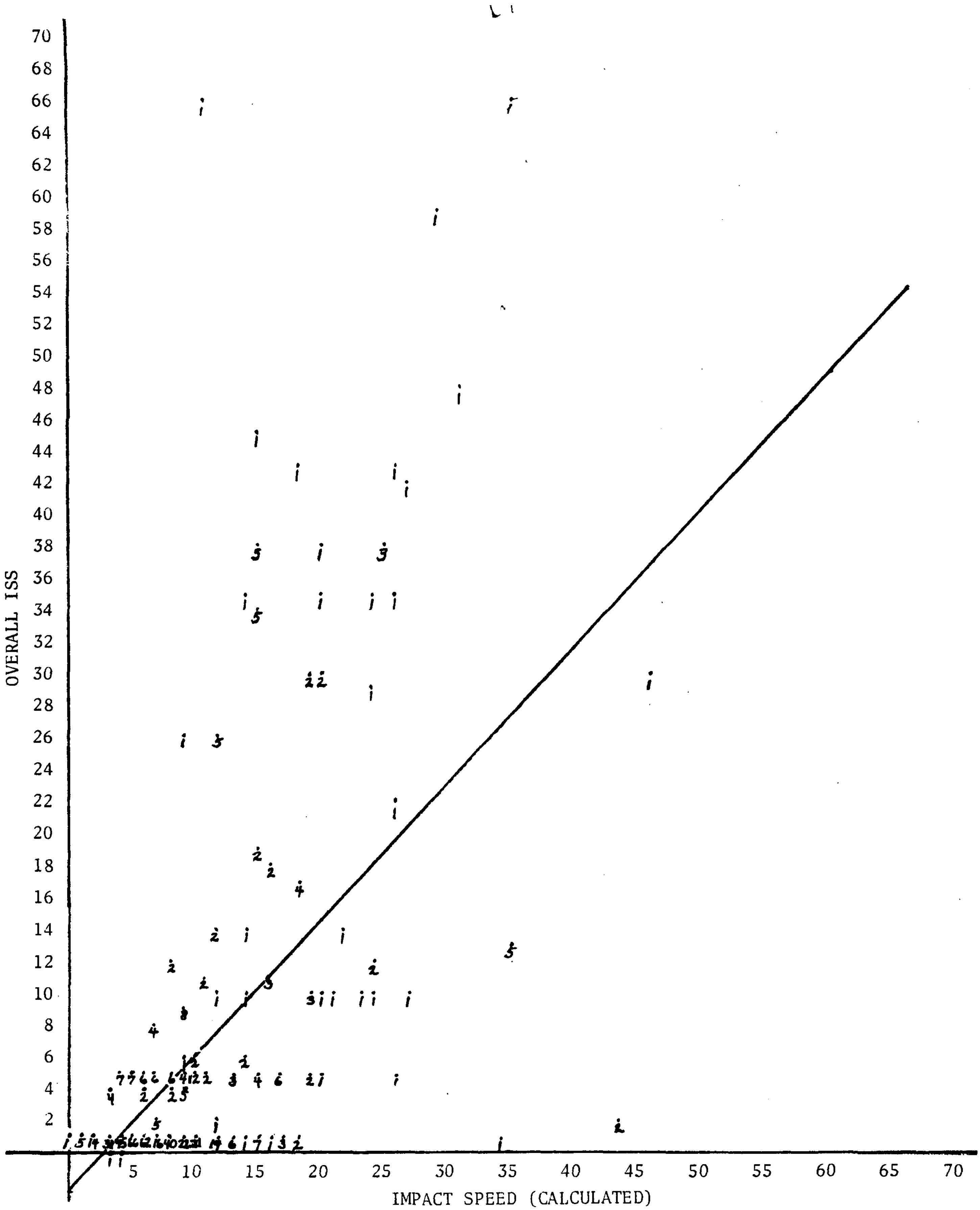


FIGURE 4-2 - OVERALL ISS BY IMPACT SPEED - FRONTAL IMPACTS WEIGHTED
PEDESTRIAN AGE ≤ 10

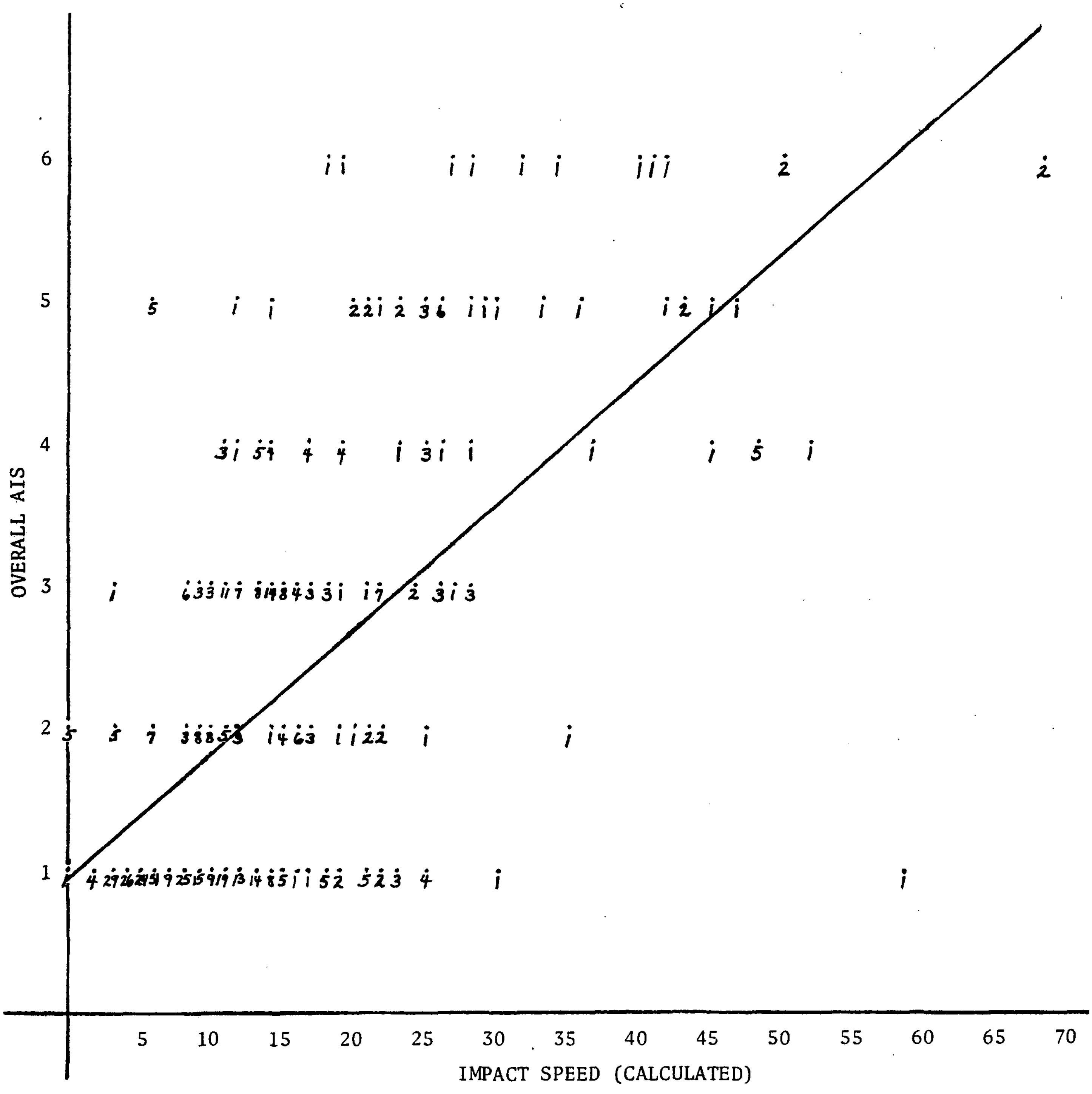


FIGURE 4-3 - OVERALL AIS BY IMPACT SPEED - FRONTAL IMPACTS WEIGHTED
PEDESTRIAN AGE > 10

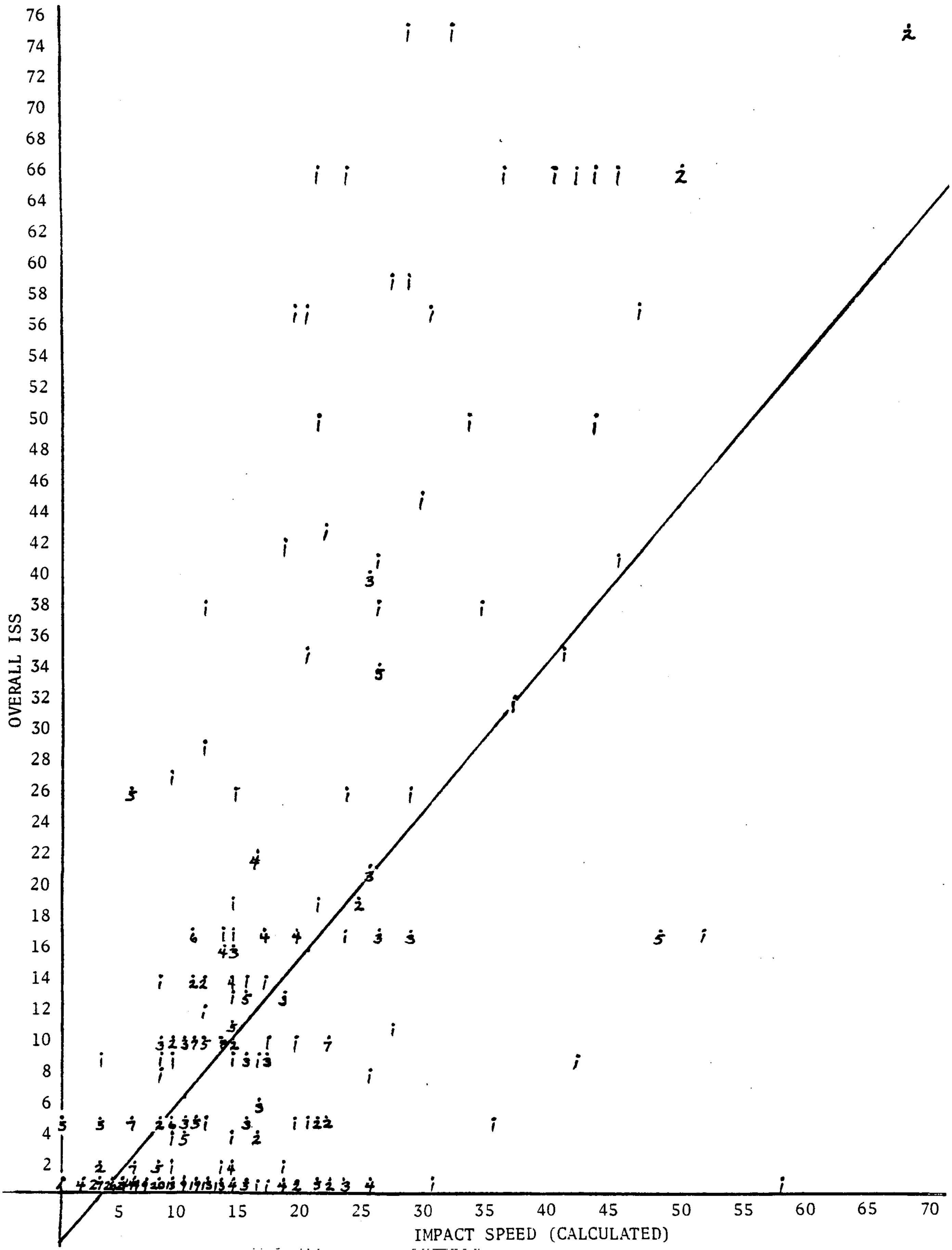


FIGURE 4-4 - OVERALL ISS BY IMPACT SPEED - FRONTAL IMPACTS WEIGHTED PEDESTRIAN AGE > 10

Furthermore, the intercepts of all four models are reasonably close to zero, indicating no injury in 0 MPH collisions:* a desirable characteristic.

The effects of impact speed will be examined within the other severity-related factors throughout the remainder of this section. It is noteworthy, however, to observe that because of the amount of variance in injury severity accounted for by impact speed, in addition to random error (due to individual differences among people in general), the increase in predictability of other variables will be limited.

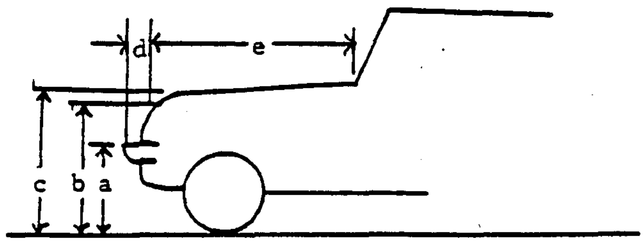
4.3 Effects of Vehicle Geometry in Frontal Impacts

The variables which define the frontal geometry of a vehicle are: the bumper height, bumper lead, contact height, hood height, and the hood length. Figure 4-5 illustrates the various measures of the front-end profile.

The relationship among the hood height, bumper height, and bumper lead can be summarized in a single variable -- the lead angle. A schematic representation of this variable was provided in Figure 3-2. It should be noted that the use of the hood height rather than the contact height in computing lead angle was arbitrary. Since the difference between the variables is minimal, there would be little effect on the computation of the lead angle.

---

* There are a number of cases in which impact speeds of 0 MPH "caused" injury; the pedestrian, in these cases, may have supplied the kinetic energy.



a) bumper height

b) contact height (to the end of the vertical)*

c) hood height

d) bumper lead

e) hood length

*Contact height is the vehicle measurement from the ground to the point at which the hood begins to slope or from ground to hood edge or edge of upper grille panel depending upon the vehicle configuration.

FIGURE 4-5. ILLUSTRATION OF FRONT GEOMETRY METRICS

Instead of directly examining the effect of the vehicle geometry on pedestrian injury severity, the dependent measure chosen was the vehicle-pedestrian interaction data element. (This was selected because it was felt that injury severity is largely a result of pedestrian kinematics which are in turn caused by the vehicle profile.) The best measure of pedestrian kinematics is the vehicle-pedestrian interaction variable.

In order to simplify the analyses, accidents were limited to frontals and the vehicle-pedestrian categories were regrouped into the following categories (refer to Table 3-7): "Carried by vehicle", "Thrown by vehicle", "Knocked to pavement", and "Shunted". Note that "Other" and "Thrown over vehicle top" were not included. In the latter case, there were only twenty-four instances of such an event, and all pedestrians so affected were adults.

Mean values of the metric of interest were calculated for the vehicle-pedestrian interaction categories. The results of the analysis of the bumper height are given in Table 4-2 for adults (over ten years old) and for children.

TABLE 4-2. - BUMPER HEIGHT BY VEHICLE-PEDESTRIAN INTERACTION

Vehicle-Pedestrian Interaction	Children N	Children Mean (Inches)	Children σ_m *	Adult N	Adult Mean (Inches)	Adult σ_m
Carried by Vehicle	13	19.9	0.3	149	20.3	0.2
Thrown by Vehicle	190	20.9	0.1	202	21.0	0.2
Knocked to Pavement	242	21.0	0.1	272	20.8	0.1
Shunted (Corner Impact)	9	20.6	0.7	24	20.9	0.4
TOTAL	454	20.9	0.1	647	20.8	0.1

*Standard error of the mean.

There is little indication in Table 4-2 that the variations in bumper height had any effect on the pedestrian kinematics. Ignoring the corner impacts, however, note that the data for children has a slight trend relating the vehicle-pedestrian interaction to the bumper height; specifically, the probability of the pedestrian rotating onto the vehicle hood seems to decrease with increasing bumper height. The difference is statistically significant ($F_{2,426} = 3.27$; $p \leq 0.04$). No such trend is apparent with adults, perhaps reflecting that the contact with the bumper is far enough below the pedestrian's center of gravity so that the kinematics are not affected. It should also be noted that there was little variation in the bumper heights within the sample; approximately three quarters of the striking vehicles' bumpers were between 19 and 22 inches above the ground.

The second parameter of the vehicle profile examined was the lead angle. Descriptive statistics of the lead angle for each grouping of the vehicle-pedestrian interaction are given in Table 4-3. There was a minor definitional problem with the lead angle computation in which a number of vehicles had lead angles of zero degrees. Examples of this would be a Chevrolet Corvette or a Volkswagen Beetle, both of which do not have any front grille area. Consequently, the hood and bumper heights were the same. These zero values may have the effect of spuriously deflating the mean lead angle. The relative frequencies of the zero lead angles are consistent with the rank order of the mean values. In other words, while the average figures may be affected, the relationship among them is not altered.

TABLE 4-3. - LEAD ANGLE BY VEHICLE-PEDESTRIAN INTERACTION

Vehicle-Pedestrian Interaction	Children			Adult		
	N	Mean (Degrees)	σ_m	N	Mean (Degrees)	σ_m
Carried by Vehicle	13	75.3	1.9	137	71.4	1.0
Thrown by Vehicle	174	74.0	0.6	183	72.6	0.9
Knocked to Pavement	220	73.1	0.5	249	73.5	0.5
Shunted (Corner Impact)	9	72.8	1.7	24	74.7	1.3
TOTAL	416	73.5	0.4	593	72.8	0.4

The variance in lead angle does not result in a statistically significant difference. There does, however, appear to be a slight trend in the adult data, suggesting there may be a tendency to knock the pedestrian forward (rather than rotating onto the hood) with increasingly higher lead angles (that is, a flatter, blunter profile).

The analysis of the contact mean height and hood height data elements also provided little in the way of support to the hypothesis that the frontal geometry affected the pedestrian kinematics. Descriptions of the two distributions are given in Table 4-4 and 4-5, categorized by the vehicle-pedestrian interaction variable. It should be noted that analyses that included vehicle size did demonstrate differences for children and adults.

In examining these tables, it can be seen that there is a slight relation between the height of the hood and the pedestrian reaction to the impact. However, it was confirmed statistically in the case of the contact height variable, using a General Linear Models regression, that the vehicle-pedestrian interaction accounts for less than three percent of the variance. This is not a strong effect. No statistically significant trend was found using the hood height data element.

TABLE 4-4. - HOOD HEIGHT BY VEHICLE-PEDESTRIAN INTERACTION

Vehicle-Pedestrian Interaction	Children			Adults		
	N	Mean (Inches)	σ_m	N	Mean (Inches)	σ_m
Carried by Vehicle	13	33.3	0.5	146	33.6	0.3
Thrown by Vehicle	187	34.6	0.4	196	34.7	0.4
Knocked to Pavement	239	34.6	0.3	266	34.7	0.3
Shunted (Corner Impact)	9	33.7	0.7	24	34.7	0.9
TOTAL	448	34.5	0.2	632	34.4	0.2

TABLE 4-5. - CONTACT HEIGHT BY VEHICLE-PEDESTRIAN INTERACTION

Vehicle-Pedestrian Interaction	Children			Adult		
	N	Mean (Inches)	σ_m	N	Mean (Inches)	σ_m
Carried by Vehicle	13	31.0	0.7	148	30.5	0.3
Thrown by Vehicle	188	32.1	0.3	200	32.6	0.4
Knocked to Pavement	239	32.5	0.3	265	32.5	0.3
Shunted (Corner Impact)	9	31.3	1.0	24	32.3	0.9
TOTAL	449	32.2	0.2	637	32.1	0.2

Thus far, only vehicle parameters have been investigated. This approach ignores any interaction between the vehicle geometry and the struck pedestrians. In order to include the pedestrian in this analysis, the distance between the pedestrian's hip and the contact height was computed. This was used to relate the point of contact to the pedestrian's center of gravity. A positive relative height was indicative of the hood contacting the pedestrian above the hip; a negative value, below the hip. These results are presented in Table 4-6.

TABLE 4-6. - RELATIVE CONTACT HEIGHT BY VEHICLE-PEDESTRIAN INTERACTION

Vehicle-Pedestrian Interaction	Children N	Children Mean (Inches)	Children σ_m	Adult N	Adult Mean (Inches)	Adult σ_m
Carried by Vehicle	7	0.4	2.0	71	-5.9	0.7
Thrown by Vehicle	115	7.3	0.6	104	-3.8	0.6
Knocked to Pavement	174	7.7	0.5	150	-3.6	0.5
Shunted (Corner Impact)	5	6.3	2.2	15	-4.2	1.2
TOTAL	301	7.3	0.4	340	-4.2	0.3

In the child pedestrian data, there is a decreasing tendency for the struck person to be rotated onto the hood as the contact occurs farther and farther above the hip. The results for the adult pedestrians are interesting since the mean relative height of the "Thrown by Vehicle" category falls between the means of the other two categories. Also, persons carried by the vehicle have the largest negative value, -5.9, as one would expect.

The parameters discussed previously which appear to affect the pedestrian post-impact trajectory, i.e., contact and bumper heights and the relative contact height, are, at best, only a partial explanation of the kinematics resulting from a pedestrian impact. A much stronger association is evident using the impact speed variable. Descriptive statistics are given in Table 4-7; only calculated impact speeds were included.

TABLE 4-7. - IMPACT SPEED BY VEHICLE-PEDESTRIAN INTERACTION

Vehicle-Pedestrian Interaction	Children			Adult		
	N	Mean (MPH)	σ_m	N	Mean (MPH)	σ_m
Carried by Vehicle	6	19.3	4.8	59	19.8	1.7
Thrown by Vehicle	120	13.2	0.7	80	16.9	1.1
Knocked to Pavement	114	6.5	0.4	88	9.2	0.8
Shunted (Corner Impact)	4	8.3	1.8	7	15.6	4.4
TOTAL	244	10.1	0.5	234	14.7	0.7

Neglecting again the shunted category, there is a definite trend apparent in these data. In particular, the higher impact speeds tend to throw the pedestrians onto the hood; as the impact speeds decrease, the pedestrian contacts the hood/hood front and is thrown to the pavement. Still lower impact speeds knock the pedestrian to the pavement.

The vehicle-pedestrian interaction accounts for approximately 21 percent of the variance in the impact speed variable. Thus, while the pedestrian kinematics are affected somewhat by the frontal geometry of the striking vehicle, it appears that the most important factor in the resulting trajectory is the speed at which the pedestrian was struck.

The relatively limited effect of the frontal geometry on pedestrian kinematics is surprising. It is thought that this may be associated with the relatively small number of serious and fatal accidents, in which the effects of vehicle geometry may have been masked by the majority of the cases, which involved only relatively minor injury. The masking effect may have been heightened by utilizing the vehicle-pedestrian interaction as the independent variable instead of the pedestrian injury level. This approach was employed, since it is believed that bumper height, or any other geometric variable, generally does not cause injuries directly; rather, the frontal geometry variables influence pedestrian kinematics and area contacted, which, in turn, are thought to be related to pedestrian injury.

It is noted that evidence supporting the hypotheses concerning the importance of frontal geometry (in terms of vehicle type -- minicar, subcompacts, etc.) is presented in Section 4-10.

It has been postulated by Ashton and Mackay (Reference 12) that the vehicle profile influences the probability of lower extremity/hip fracture. More specifically, they reported that bumper lead angles under 70° were involved in a majority of lower extremity fractures caused by the bumper and related assembly. In brief, they stated that "decreasing the bumper lead angle, i.e., increasing the bumper lead, increased the percentage of fractures resulting from bumper contact and decreased the percentage resulting from bonnet contact". Their results were not statistically significant. Initially, the effect of lead angle was investigated for all lower extremity/hip injuries in the PICS file. Mean lead angles were computed for each lower leg lesion sustained; mean impact speeds were also calculated for each lesion. The results are given in Table 4-8.

TABLE 4-8. - LEAD ANGLE AND IMPACT SPEED FOR LEG LESIONS CAUSED BY CONTACTS WITH VEHICLES

	Lead Angle			Impact Speed		
Lesion	N	Mean (Degrees)	σ_m	N	Mean (MPH)	σ_m
Abrasion	101	71.9	1.3	47	16.7	1.5
Amputation	1	73.3	---	2	59.0	---
Avulsion	1	69.0	---	2	9.5	---
Contusion	367	71.9	0.5	161	11.3	0.7
Dislocation	5	75.8	3.7	3	15.7	1.9
Fracture	252	73.3	0.6	128	21.5	1.0
Laceration	34	70.0	2.4	8	18.4	4.4
Pain	144	72.8	0.6	72	10.6	0.8
Sprain	19	70.7	1.8	6	16.0	2.9
Other	9	72.2	2.4	2	17.5	---
TOTAL	933	72.4	0.3	431	15.3	0.5

In Table 4-8, there is nothing extraordinary about the lead angle when fractures are sustained by the pedestrian. In fact, the lead angle in accidents in which leg fractures occurred is the second highest (i.e., blunter than average) among all the lower leg lesions; only dislocations exhibited a higher mean lead angle. It would seem, rather, that the impact speed is more closely related to the occurrence of lower leg fractures. The 21.5 MPH average impact speed of fractures is ranked second, behind amputations (with a cell frequency of only 2). Note, however, the magnitude of the standard errors for the mean impact speed. Because of their size, no general statement can be made with any confidence concerning the influence of impact speed. Analysis of impact speeds from all data sources (not just those calculated) agrees well with these results.

Ashton and Mackay, as mentioned earlier, suggested that lower extremity and hip fractures were caused by the bumper and associated assemblies at lead angles below 70° and shifted to hood face/grille at lead angles above 80°. Accordingly, the lead angles for vehicles causing lower extremity and pelvic hip *fractures through bumper or hood face/grille contacts by pedestrians* $\geq$*10* years of age, were examined. A summary is given in Table 4-9.

The distribution of lead angles for all vehicles involved in frontal impacts is provided in Table 4-9a (Column 1). The distribution of lead angles for all lower extremity fractures caused by the bumper or the hood face/grille shown in Column 2 is quite similar to that for all lead angles. Thus, the distribution of fractures by lead angle is proportionate to the distribution of vehicles.

The percentage of fractures by lead angle based on total vehicles is shown in Column 3. There is a slightly lower percentage of fractures at lead angles above 80°, but below that level there is no apparent difference. This result is generally a reflection of bumper-caused fractures in Column 4: a lower incidence of fractures is observed as lead angle increases. For hood face/grille-caused fractures the percentage is greater for successively larger lead angles. It should be noted, however, that the percentage of fractures associated with the bumper is always larger than that associated with the hood face/grille area (Columns 4 and 5).

TABLE 4-9a. - LEAD ANGLE DATA FOR SPECIFIED FACTORS IN FRONTAL IMPACTS - AGE $\geq$10 YEARS

Lead Angle	1 Total Vehicles		2 Dist. of Fracs. by Bumper & Hd. F./Gr.		Percentage of Lower Ext. and Pelvic-Hip Fractures Based on Total Vehicles: 3 Bumper & Hd. F./Gr. (3/1)		4 Bumper Only (4/1)		5 Hd. F./Gr. Only (5/1)	
	#	%	#	%	#	%	#	%	#	%
$\leq 70^\circ$	328	30.8	69	31.1	69	21.0	48	14.6	21	6.4
$>70<80^\circ$	504	47.3	107	48.2	107	21.2	67	13.3	40	7.9
$>80^\circ$	233	21.9	46	20.7	46	19.7	25	10.7	21	9.0
TOTAL	1,065	100.0	222	100.0	222	20.8	140	13.1	82	7.8

Table 4-9b indicates that 99.3 percent of all bumper injuries are sustained by the lower leg and thigh, for those ten years of age or older. On the other hand, 95.1 percent of all hood face/grille area injuries are sustained by the thigh and pelvic-hip area. In both instances, a very high proportion of the injuries are sustained by a single area: the lower leg for the bumper and the pelvic-hip area for the hood face/grille area.

TABLE 4-9b. - DISTRIBUTION OF LOWER EXTREMITY INJURIES BY BODY AREA INJURED AND INJURY SOURCE - AGE ≥10 YEARS

	Bumper			Hood Face/ Grille		
	#	%		#	%	
Lower Leg	116	82.9	99.3 (Lower Leg + Thigh)	4	4.9	
Thigh	23	16.4		24	29.3	95.1 (Thigh + Pelvic-Hip)
Pelvic-Hip	1	.7		54	65.9	
TOTAL	140	100.0		82	100.0	

Since all pedestrians were upright when struck, it is clear that the thigh represents an overlap area for bumper and hood face/grille contacts depending upon a person's height; i.e., smaller individuals in the ≥10 year old group receive thigh contacts from the bumper while larger ones in that age group are contacted by the hood face/grille. Effectively, the bumper does not cause pelvic-hip injuries to those ≥10 years of age, nor does the hood face/grille cause an appreciable number of lower leg injuries.

The data indicate that it is not a matter of a shift in fracture source from bumper to hood face/grille as the lead angle increases but rather two totally separate phenomena: Lower extremity (mostly lower leg) injuries which are caused by the bumper appear to decrease as lead angle increases while thigh/pelvic-hip injuries which are caused by the hood face/grille, decrease. It should also be noted that there were only 31 pedestrians who sustained fractures from both the bumper and hood face/grille area.

Some caution is advised in using the lead angle data because the association between bumper-lower-leg injury and hood face/grille-pelvic-hip injury is so great that the lead angle may have little meaning. They may, indeed, be due to vehicle type (see Table 4-9c) and other combinations of front end configuration such as hood height and curvature.

Table 4-9c. - LEAD ANGLE BY VEHICLE TYPE

Lead Angle	Minicar	Compact	Inter-mediate	Full Size	Luxury/ Limo	Vans	Pickups	Total
<70	44.1	29.8	37.3	16.1	7.4	3.1	0.0	27.4
≥80	9.4	18.8	13.3	24.3	29.6	81.3	49.4	21.5
N	202	208	263	218	54	32	79	1,056

The last parameter of the vehicle geometry is the hood length. This parameter was examined in the context of pedestrian head contacts with the windshield, windshield trim, A-pillars, and wiper hardware. In Table 3-32, it was found that 71 percent of the known hood lengths were between 50 and 70 inches long.

In order to determine those factors which contribute to windshield area contacts, data from all pedestrian accidents were examined. The factors included were the hood length, the pedestrian height, the impacting speed, and a fourth variable - the relative length - obtained by subtracting the hood length and height from the pedestrian height. Descriptive statistics for these data elements were computed for the set of pedestrians who did not strike the windshield and those who did. The results are given in Table 4-10.

TABLE 4-10. - PARAMETERS INVESTIGATED FOR RELATIONSHIP TO WINDSHIELD IMPACTS

	Windshield Contact			No Windshield Contact		
Variable	N	Mean	σ_m	N	Mean	σ_m
Hood Length (inches)	74	51.6	1.3	973	55.6	0.3
Pedestrian Height (inches)	73	67.4	0.5	1,130	57.2	0.3
Relative Length (inches)	58	-16.3	1.5	788	-33.3	0.5
Speed-Calculated (MPH)	27	25.7	3.1	472	12.0	0.4
Speed-All Sources (MPH)	90	23.2	1.3	1,425	11.0	0.2

As can be seen in Table 4-10, the pedestrian height, impact speed, and relative length variables all demonstrate substantial differences in their average values for the windshield and no windshield contact group. The pedestrian height in the no windshield contact variable contains a large number of heights from child pedestrians, who rarely contacted vehicle components near the windshield.

In order to assess which of the three variables identified in Table 4-10 is most influential, a stepwise multiple regression was undertaken. Windshield contact was represented as a binary variable; i.e., 0 or 1; this was the dependent variable for the regression model. The first variable entered in the model was the impact speed,* which accounted for about 11 percent of the variability in the windshield contact indicator. The relative length data elements were entered next, and its inclusion accounted for an additional five percent of the variance. The pedestrian height variable alone did not significantly improve the predictability of windshield contact, and was, therefore, excluded; pedestrian height, of course, enters into the computation of the relative length.

It would seem then that the vehicle geometry plays only a secondary role in the overall pedestrian injury generation process; rather, the primary factor is the speed at which the pedestrian is struck. It should be emphasized that all of the accidents within the Pedestrian Accident Data Base involved vehicles with traditional bumper/front end assemblies. None of these vehicles were equipped with soft, "pro-pedestrian" front ends.

At this point, it is appropriate to note that there were only two reported instances in which a pedestrian who contacted the hood then contacted

---

* Impact speeds from all sources were used in this exercise since there were so few computed impact speeds in the "struck windshield" category.

an under-hood component (such as the air cleaner). Some of the literature (Reference 13) suggested that the air cleaner, suspension support points, etc., beneath the hood, were hazards to pedestrians. The fact that they were not frequently involved may mean that they are not hazardous, or it may reflect the fact that they may be difficult to document.

4.4 Vehicle Body Style and Injury

In Tables 4-1I and 4-12, the body style of the striking vehicle is recorded in terms of the overall AIS rating for pedestrians 10 years of age or younger and those older than 10. The passenger car category includes passenger cars, stationwagons, convertibles, and cars with pickup bodies (e.g., El Camino); vans include both passenger and cargo vans.

TABLE 4-11. - BODY STYLE BY HIGHEST AIS - PEDESTRIAN AGE ≤ 10

	Body Style					
AIS	Passenger Car	Van	Pickup	Other	Unknown	Total
1-3	599 (86.1)	20 (74.1)	55 (85.9)	2 (66.7)	7 (87.5)	683 (85.6)
4	29 (4.2)	0	2 (3.1)	0	0	31 (3.9)
5,6	28 (4.0)	4 (14.8)	2 (3.1)	0	0	34 (4.3)
8	40 (5.7)	3 (11.1)	5 (7.8)	1 (33.3)	1 (12.5)	50 (6.3)
9	0 (---)	0 (---)	0 (---)	0 (---)	0 (---)	0 (---)
TOTAL	696 (100.0)	27(100.0)	64(100.0)	3(100.0)	8(100.0)	798(100.0)

TABLE 4-12. - BODY STYLE BY HIGHEST AIS - PEDESTRIAN AGE > 10

AIS	Body Style: Passenger Car		Van		Pickup		Other		Unknown		Total	
1-3	832	(77.1)	41	(70.7)	67	(70.5)	7	(100.0)	13	(52.0)	960	(75.9)
4	67	(6.2)	4	(6.9)	8	(8.4)	0		2	(8.0)	81	(6.4)
5,6	105	(9.7)	7	(12.1)	16	(16.8)	0		8	(32.0)	136	(10.8)
8	75	(7.0)	6	(10.3)	4	(4.2)	0		2	(8.0)	87	(6.9)
9	5	(---)	0	(---)	0	(---)	0	(---)	0	(---)	5	(---)
TOTAL	1084	(100.0)	58	(100.0)	95	(100.0)	7	(100.0)	25	(100.0)	1269	(100.0)

PLEASE NOTE: **For the tables in the remaining sections, figures in parentheses represent the percentage of the total less unknowns.**

Data for 798 children and 1,269 adults are presented in Tables 4-11 and 4-12. The proportion of persons involved with the various vehicle types is rather similar for both age groups. The adults, however, sustained a much larger proportion of life threatening (AIS 4-6) injuries than the children: 17.2 percent were rated AIS 4-6 compared with 8.1 percent for children. Thus, the proportion of adults sustaining AIS 4-6 injuries is more than double that for children.

Passenger car impacts resulted in the fewest AIS 4-6 injuries for adults (15.9 percent) while pickup impacts resulted in the fewest for children (6.2 percent). For each vehicle type there were more AIS 4-6 injuries for adults than for children. The highest proportion of AIS 4-6 injuries for children was caused by vans (14.8 percent), for adults it was pickups (25.3 percent).

In addition to the overall AIS rating, the body area sustaining the severest injury (the body area associated with the highest AIS) is useful in examining how pedestrian injury relates to vehicle body style.

Tables 4-13 and 4-14 provide information concerning the relationship between vehicle body style and the pedestrian body area that sustained the severest injury. The Total column reveals that the severest injury to both

TABLE 4-13 - BODY STYLE BY BODY AREA SUSTAINING THE SEVEREST INJURY - PEDESTRIAN AGE ≤10

Body Area	Passenger Car		Van		Pickup		Other		Unknown		Total	
Head and Neck	165	(24.6)	8	(32.0)	22	(34.9)	2	(66.7)	1	(14.3)	198	(25.8)
Face	129	(19.3)	6	(24.0)	6	(9.5)	0		2	(28.6)	143	(18.6)
Chest	14	(2.1)	0		3	(4.8)	0		1	(14.3)	18	(2.3)
Abdomen	29	(4.3)	3	(12.0)	2	(3.2)	0		0		34	(4.4)
Back	15	(2.2)	0		2	(3.2)	0		0		17	(2.2)
Pelvic-Hip	35	(5.2)	0		4	(6.3)	0		0		39	(5.1)
Upper Extremities	75	(11.2)	2	(8.0)	7	(11.1)	0		0		84	(10.9)
Lower Extremities	208	(31.0)	6	(24.0)	17	(27.0)	1	(33.3)	3	(42.9)	235	(30.6)
Whole Body	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)	0	(0.0)
Unknown	2	(---)	0	(---)	0	(---)	0	(---)	0	(---)	2	(---)
TOTAL	672	(100.0)	25	(100.0)	63	(100.0)	3	(100.0)	7	(100.0)	770	(100.0)

TABLE 4-14 - BODY STYLE BY BODY AREA SUSTAINING THE SEVEREST INJURY PEDESTRIAN AGE >10

Body Area	Passenger Car		Van		Pickup		Other		Unknown		Total	
Head and Neck	209	(20.6)	17	(32.7)	26	(28.0)	2	(28.6)	7	(31.8)	261	(21.9)
Face	51	(5.0)	4	(7.7)	8	(8.6)	1	(14.3)	2	(9.1)	66	(5.5)
Chest	34	(3.3)	4	(7.7)	11	(11.8)	0		2	(9.1)	51	(4.3)
Abdomen	43	(4.2)	0		7	(7.5)	0		2	(9.1)	52	(4.4)
Back	31	(3.0)	2	(3.8)	3	(3.2)	0		0		36	(3.0)
Pelvic-Hip	78	(7.7)	4	(7.7)	6	(6.5)	1	(14.3)	2	(9.1)	91	(7.6)
Upper Extremities	137	(13.5)	11	(21.2)	17	(18.3)	1	(14.3)	1	(4.5)	167	(14.0)
Lower Extremities	434	(42.7)	10	(19.2)	15	(16.1)	2	(28.6)	6	(27.3)	467	(39.2)
Whole Body	0		0		0		0		0		0	
Unknown	2	(---)	0	(---)	0	(---)	0	(---)	0	(---)	2	(---)
TOTAL	1,019	(100.0)	52	(100.0)	93	(100.0)	7	(100.0)	22	(100.0)	1,193	(100.0)

children and adults involved the lower extremities (30.6 and 39.2 percent, respectively). Head and neck injuries ranked second with 25.8 percent for children and 21.9 percent for adults. Injuries to the face, upper extremities and pelvic-hip area ranked third through fifth for both age groups, but not in the same sequence. The major difference between children and adults with respect to injuries to these three body areas was that children sustained far more facial injuries as their most severe injury, than did adults.

The described injury rankings are a direct reflection of passenger car data which dominate the body style data. Vans and pickups, however, were associated with a different injury pattern. For both children and adults, head and neck injuries ranked first when a van or pickup was involved. Lower extremity injuries ranked second for both children and adults. The major differences from cars are the increase in head injuries and a corresponding decrease in lower extremity injuries for adults.

Tables 4-15 and 4-16 provide information concerning the source of the severest injury to a pedestrian when passenger cars, vans and pickups were the involved vehicles. For both adults and children, contact with the pavement most often was the source of the pedestrian's severest injury for all three vehicle types. However, these contacts resulted in the severest injury far more frequently for children than for adults. When vans were the striking vehicle, the proportion of pavement contacts which caused the severest injury was larger than when pickups or passenger cars were the striking vehicle.

The front bumper ranked second overall as a source of injury for both children and adults, and the percentages associated with passenger cars were much higher than those for other vehicle types. The ranking of the next four sources of injury associated with passenger cars for children was: front fender, grille/headlight area, and tires/wheels, and hood top. For adults, the ranking was: hood top, front fender and energy transfer and the hood face (with the same percentage).

TABLE 4-15 - BODY STYLE BY SOURCE OF SEVEREST INJURY - PEDESTRIAN AGE ≤ 10

Source	Passenger Car		Van		Pickup		Other		Unknown		Total	
Front Bumper	115	(18.8)	0		7	(12.3)	0		0		122	(17.5)
Grille/Headlights	41	(6.7)	2	(8.7)	9	(15.8)	0		0		52	(7.5)
Hood Face	28	(4.6)	2	(8.7)	5	(8.8)	0		0		35	(5.0)
Hood Top	35	(5.7)	0		1	(1.8)	0		0		36	(5.2)
Cowl/Wiper Blade Mount	0		0		0		0		0		0	
Front Fender	44	(7.2)	1	(4.3)	4	(7.0)	0		0		49	(7.0)
Radio Antenna	0		0		0		0		0		0	
Windshield & Trim	0		0		0		0		0		0	
Roof	0		0		0		0		0		0	
A-Pillar	4	(0.7)	0		0		0		0		4	(0.6)
B,C,or D-Pillar	2	(0.3)	0		0		0		0		2	(0.3)
Side Rail	1	(0.2)	0		0		0		0		1	(0.1)
Door & Lower Side	12	(2.0)	0		0		0		0		12	(1.7)
Rear Fender/Quarter Panel	11	(1.8)	0		0		0		0		11	(1.6)
Tailgate/Trunk Deck	0		0		0		0		0		0	
Rear Bumper	3	(0.5)	0		0		0		0		3	(0.4)
Tires/Wheels	35	(5.7)	6	(26.1)	6	(10.5)	1	(33.3)	0		48	(6.9)
Undercarriage	1	(0.2)	0		0		0		0		1	(0.1)
Energy Transfer	25	(4.1)	0		3	(5.3)	0		0		28	(4.0)
Accessories/Ornaments	11	(1.8)	0		1	(1.8)	0		0		12	(1.7)
Other Pedestrian/Vehicle	0		0		0		0		0		0	
Pavement	240	(39.2)	12	(52.2)	21	(36.8)	2	(66.7)	2	(28.6)	277	(39.7)
Other	4	(0.7)	0		0		0		0		4	(0.6)
Non-Contact Injury Source	0		0		0		0		0		0	
Unknown	60	(---)	2	(---)	6	(---)	0		5	(71.4)	73	(---)
TOTAL	672	(100.0)	25	(100.0)	63	(100.0)	3	(100.0)	7	(100.0)	770	(100.0)

TABLE 4-16 - BODY STYLE BY SOURCE OF SEVEREST INJURY - PEDESTRIAN AGE >10

Source	Passenger Car		Van		Pickup		Other		Unknown		Total	
Front Bumper	208	(22.8)	3	(6.1)	8	(10.3)	1	(14.3)	0		220	(20.9)
Grille, Headlights	39	(4.3)	3	(6.1)	5	(6.4)	0		0		47	(4.5)
Hood Face	64	(7.0)	5	(10.2)	9	(11.5)	0		1	(20.0)	79	(7.5)
Hood Top	75	(8.2)	0		3	(3.8)	0		0		78	(7.4)
Cowl/Wiper Blade Mount	4	(0.4)	0		0		0		0		4	(0.4)
Front Fender	73	(8.0)	1	(2.0)	2	(2.6)	1	(14.3)	1	(20.0)	78	(7.4)
Radio Antenna	1	(0.1)	0		0		0		0		1	(0.1)
Windshield & Trim	44	(4.8)	1	(2.0)	6	(7.7)	0		0		51	(4.8)
Roof	3	(0.3)	0		0		0		0		3	(0.3)
A-Pillar	2	(0.2)	0		1	(1.3)	0		0		3	(0.3)
B,C, or D-Pillar	1	(0.1)	0		0		0		0		1	(0.1)
Side Rail	2	(0.2)	0		0		0		0		2	(0.2)
Door & Lower Side	14	(1.5)	0		2	(2.6)	1	(14.3)	2	(40.0)	19	(1.8)
Rear Fender/Quarter Panel	12	(1.3)	1	(2.0)	1	(1.3)	0		0		14	(1.3)
Tailgate/Trunk Deck	4	(0.4)	1	(2.0)	0		1	(14.3)	0		6	(0.6)
Rear Bumper	6	(0.7)	0		1	(1.3)	0		0		7	(0.7)
Tires/Wheels	29	(3.2)	2	(4.1)	1	(1.3)	0		0		32	(3.0)
Undercarriage	7	(0.8)	0		0		0		0		7	(0.7)
Energy Transfer	64	(7.0)	3	(6.1)	3	(3.8)	0		0		70	(6.7)
Accessories/Ornaments	17	(1.9)	5	(10.2)	11	(14.1)	1	(14.3)	0		34	(3.2)
Other Pedestrian/Vehicle	3	(0.3)	0		2	(2.6)	0		1	(20.0)	6	(0.6)
Pavement	235	(25.7)	23	(46.9)	23	(29.5)	2	(28.6)	0		283	(26.9)
Other	4	(0.4)	1	(2.0)	0		0		0		5	(0.5)
Non-Contact Injury Source	2	(0.2)	0		0		0		0		2	(0.2)
Unknown	108	(---)	3	(---)	15	(---)	0		18	(---)	144	(---)
TOTAL	1,021	(100.00)	52	(100.0)	93	(100.0)	7	(100.0)	23	(100.0)	1,196	(100.0)

*Mostly side mounted rearview mirror

When children were struck by vans or pickups, the sources of injury tended to cluster in frontal areas below the hood and windshield. Only one child sustained his severest injury from contact with the hood top. Tires ranked second as a source of severest injury for one out of four children struck by vans suggesting that they were often knocked down and then struck or run over by tires.

For adults struck by vans, accessories or ornamentation (largely side mounted mirrors) ranked second as the injury source along with the hood face. Accessories also ranked second for pickups followed by the hood face.

4.5 Vehicle Body Style and Vehicle-Pedestrian Interaction

Impact type was limited to frontal impacts for the vehicle-pedestrian interaction analysis because most of the accident configurations involve the vehicle front. None of the children were rotated over the top of any of the vehicles in the study, presumably because of their small size. For the same reason, few were carried by the vehicle and these only by passenger cars. Adults experienced a small percentage of these two interactions when struck by pickups and vans. Many, however, were carried by passenger cars (22 percent).

When struck by pickups, the proportion of children who were thrown forward or knocked to the pavement is higher than for adults. Vans, however, had a greater tendency to knock children down rather than throwing them forward. This was also true for adults, although the proportion was smaller. All three vehicle types generally interacted with children in the same way, either throwing them forward or knocking them to the pavement (94.4 percent). The passenger car category had a few cases where a child pedestrian was carried by the vehicle or shunted aside. The majority of adult pedestrians also were thrown forward or knocked to the pavement when struck by vans or pickups (97.1 percent and 80.3 percent, respectively). Passenger cars in adult pedestrian accidents had 70 percent in these two categories while

24.8 percent of the pedestrians were either carried by the vehicle or rotated over its top. The passenger car/adult pedestrian interaction was the only one in which the pedestrian rotated over the vehicle top. (See Tables 4-17 and 4-18.)

TABLE 4-17. - VEHICLE-PEDESTRIAN INTERACTION BY BODY STYLE - FRONTAL IMPACTS - PEDESTRIAN AGE ≤10

Vehicle-Pedestrian Interaction	Passenger Car		Van		Pickup		Total	
Carried by Vehicle	15	(3.1)	0		0		15	(2.7)
Rotated Over Vehicle Top	0		0		0		0	
Thrown Forward	195	(39.8)	6	(31.6)	23	(51.1)	224	(40.4)
Knocked to Pavement	265	(54.1)	13	(68.4)	21	(46.7)	299	(54.0)
Shunted to Left/ Right	9	(1.8)	0		1	(2.2)	10	(1.8)
Other	6	(1.2)	0		0		6	(1.1)
Unknown	21	(---)	0	(---)	4	(---)	25	(---)
TOTAL	511	(100.0)	19	(100.0)	49	(100.0)	579	(100.0)

TABLE 4-18. - VEHICLE-PEDESTRIAN INTERACTION BY BODY STYLE - FRONTAL IMPACTS - PEDESTRIAN AGE >10

Vehicle-Pedestrian Interaction	Passenger Car		Van		Pickup		Total	
Carried by Vehicle	164	(21.6)	1	(2.9)	6	(9.8)	171	(20.0)
Rotated Over Vehicle Top	24	(3.2)	0		0		24	(2.8)
Thrown Forward	223	(29.4)	12	(35.3)	26	(42.6)	261	(30.6)
Knocked to Pavement	308	(40.6)	21	(61.8)	23	(37.7)	352	(41.3)
Shunted to Left/ Right	28	(3.7)	0		5	(8.2)	33	(3.9)
Other	11	(1.5)	0		1	(1.6)	12	(1.4)
Unknown	68	(---)	3	(---)	4	(---)	75	(---)
TOTAL	826	(100.0)	37	(100.0)	65	(100.0)	928	(100.0)

The average impact speeds for the three vehicle types (Table 4-19) fall within a narrow range and, consequently, do not appear to have a significant influence on vehicle body style and pedestrian kinematics.

TABLE 4-19. - AVERAGE CALCULATED IMPACT SPEED BY BODY STYLE

Average Impact Speed (MPH)	Passenger Car	Van	Pickup
$\overline{X}$	13.0	14.2	15.0
N	519	16	48
σ_m	0.4	2.9	1.7

4.6 Pedestrian Orientation, Vehicle-Pedestrian Interaction and Injury Severity

Pedestrian orientation was examined to detect any effect that this variable may have had on the pedestrian's injury pattern and/or kinematics. Prior to impact, 97.8 percent of the pedestrians were standing upright as opposed to bending, crouching or some other position. Therefore, too few alternative attitudes were recorded to determine any relationship that might exist among these variables.

Accidents in which the pedestrian was facing away from the vehicle at impact differed from the other body orientations in terms of the subsequent vehicle/pedestrian interactions. Facing away from the vehicle resulted in a relatively higher percentage of pedestrians being shunted to the left or right (for corner impacts), thrown forward or rotated over the vehicle top, and a lower proportion of pedestrians being carried by the vehicle or knocked to the pavement. The other three body orientations all produced similar vehicle/pedestrian interaction patterns, although when the pedestrian was facing the vehicle, he was more likely to be thrown forward than when his side was to the vehicle, (See Table 4-20.)

TABLE 4-20 - VEHICLE PEDESTRIAN INTERACTION BY BODY ORIENTATION AT IMPACT - FRONTAL IMPACTS

	Facing Vehicle	Facing Away	Left Side to Vehicle	Right Side to Vehicle	Other	Unknown	Total
Carried by the Vehicle	10 (13.0)	7 (10.3)	91 (12.7)	78 (14.6)	0	1 (4.3)	187 (13.1)
Rotated Over the Vehicle	1 (1.3)	3 (4.4)	8 (1.1)	12 (2.3)	0	0	24 (1.7)
Thrown Forward	29 (37.7)	27 (39.7)	249 (34.6)	177 (33.2)	1 (33.3)	9 (39.1)	492 (34.6)
Knocked to Pavement	34 (44.2)	25 (36.8)	338 (47.0)	248 (46.5)	1 (33.3)	12 (52.2)	658 (46.2)
Shunted to Left/Right	1 (1.3)	6 (8.8)	22 (3.1)	15 (2.8)	0	0	44 (3.1)
Other	2 (2.6)	0	11 (1.5)	3 (0.6)	1 (33.3)	1 (4.3)	18 (1.3)
Unknown	3 (---)	2 (---)	50 (---)	34 (---)	0 (---)	14 (---)	103 (---)
TOTAL	80 (100.0)	70 (100.0)	769 (100.0)	567 (100.0)	3 (100.0)	37 (100.0)	1,526 (100.0)

The pedestrian's body orientation relative to the vehicle was associated with only slight variations in the known AIS ratings for the severest injury (highest AIS). Pedestrians facing away from or toward the vehicle had somewhat more AIS 1-3 ratings than those pedestrians who had their side to the vehicle. The more severe injuries, AIS 4-6, were sustained by about 16 percent of those with their side toward the vehicle and about 12-13 percent of those facing toward or away from the vehicle. (See Table 4-21.)

The body area that sustained the severest injury revealed some interesting variations for the different body orientations. A few notable points are: The lower extremities sustained the severest injury most often when the pedestrian's side was toward the vehicle. The abdomen and the pelvic-hip areas sustained the severest body area injuries more frequently when the pedestrian was facing toward or away from the vehicle rather than when the pedestrian's side was toward the vehicle. The severest injury involved the upper extremities least frequently when the body orientation was "facing away from vehicle." Chest injuries were least frequent and back injuries were most likely to occur when the pedestrian was facing away. The head or neck region suffered the severest injury in fairly similar percentages for all four positions. In general, the injury pattern for pedestrians with their side to the vehicle was remarkably similar for the left and right sides. (See Table 4-22.)

TABLE 4-21 - AIS-SEVEREST INJURY BY BODY ORIENTATION - FRONTAL IMPACTS

AIS	Facing Vehicle	Facing Away	Left Side to Vehicle	Right Side to Vehicle	Other	Unknown	Total
1-3	66 (88.0)	57 (86.4)	597 (83.8)	447 (83.7)	1 (33.3)	8 (26.7)	1,176 (82.8)
4	3 (4.0)	1 (1.5)	47 (6.6)	32 (6.0)	0	4 (13.3)	87 (6.1)
5,6	6 (8.0)	8 (12.1)	68 (9.6)	55 (10.3)	2 (66.7)	18 (60.0)	157 (11.1)
TOTAL	75 (100.0)	66 (100.0)	712 (100.0)	534 (100.0)	3 (100.0)	30 (100.0)	1,420 (100.0)

TABLE 4-22. - BODY AREA WITH SEVEREST INJURY BY BODY ORIENTATION AT IMPACT RELATIVE TO VEHICLE - FRONTAL IMPACTS

	Facing Vehicle	Facing Away	Left Side to Vehicle	Right Side to Vehicle	Other	Unknown	Total
Head and Neck	17 (22.4)	19 (28.8)	190 (26.1)	137 (25.0)	2 (66.7)	15 (46.9)	380 (26.2)
Face	8 (10.5)	6 (9.1)	71 (9.7)	54 (9.9)	1 (33.3)	2 (6.3)	142 (9.8)
Chest	4 (5.3)	1 (1.5)	27 (3.7)	19 (3.5)	0	3 (9.4)	54 (3.7)
Abdomen	6 (7.9)	5 (7.6)	35 (4.8)	25 (4.6)	0	6 (18.8)	77 (5.3)
Back	2 (2.6)	7 (10.6)	16 (2.2)	14 (2.6)	0	1 (3.1)	40 (2.8)
Pelvic-Hip	10 (13.2)	9 (13.6)	51 (7.0)	39 (7.1)	0	0	109 (7.5)
Upper Extremities	13 (17.1)	3 (4.5)	82 (11.2)	63 (11.5)	0	1 (3.1)	162 (11.1)
Lower Extremities	16 (21.1)	16 (24.2)	256 (35.1)	196 (35.8)	0	4 (12.5)	488 (33.6)
Whole Body	0	0	1 (0.1)	0	0	0	1 (0.1)
Unknown	0 (---)	1 (---)	1 (---)	1 (---)	0 (---)	0 (---)	3 (---)
TOTAL	76 (100.0)	67 (100.0)	730 (100.0)	548 (100.0)	3 (100.0)	32 (100.0)	1,456 (100.0)

4.7 Vehicle Braking, Vehicle-Pedestrian Interaction, Injury Severity

The attempted avoidance maneuver of the striking vehicle was categorized in terms of braking and non-braking to determine the effect on the pedestrian's injury pattern and subsequent motion. A very important factor associated with vehicle braking is impact speed. Not surprisingly, the average impact speed (frontal impacts only) for non-braking vehicles in the PICS file was 11.8 MPH greater than for braking vehicles (Table 4-23). As mentioned in the injury sections, only calculated impact speeds were used to determine average impact speed. However, the following analyses do not control for impact speed due to the small number of calculated impact speeds in the non-braking category (8.5 percent as opposed to 41.6 percent for braking).

TABLE 4-23. - AVERAGE IMPACT SPEED BY VEHICLE BRAKING - FRONTAL IMPACTS

	Vehicle Braking	
Average Impact Speed	Yes	No
$\overline{X}$	11.9	23.7
N	464.0	35.0
σ_m	0.4	2.9

The higher average impact speed for non-braking vehicles than for braking vehicles is important to keep in mind when examining the effects of braking on pedestrian injury and kinematics. Impact speed is not only a major factor in the total accident sequence, but also strongly influences vehicle-pedestrian interactions as evidenced in Section 4.2

Vehicle-Pedestrian interaction for frontal impacts varied with respect to whether the striking vehicle's driver braked or not. Pedestrians struck by braking vehicles were more likely to be thrown forward or knocked to the pavement and less apt to be carried by the vehicle or rotated over its top, than people struck by non-braking vehicles. It is worth noting that 13.4 percent of the vehicle-pedestrian interactions for non-braking vehicles were unknown. See Table 4-24.

TABLE 4-24. - VEHICLE-PEDESTRIAN INTERACTION BY VEHICLE BRAKING - FRONTAL IMPACTS

Vehicle-Pedestrian Interaction	Vehicle Braking Yes	%	No	%	Total	%
Carried by vehicle	120	(11.2)	67	(18.8)	187	(13.1)
Rotated over vehicle top	8	(0.7)	16	(4.5)	24	(1.7)
Thrown forward	387	(36.3)	105	(29.5)	492	(34.6)
Knocked to pavement	511	(47.9)	147	(41.3)	658	(46.2)
Shunted to left/right	29	(2.7)	15	(4.2)	44	(3.1)
Other	12	(1.1)	6	(1.7)	18	(1.3)
Unknown	48	(---)	55	(---)	103	(---)
TOTAL	1,115	(100.0)	411	(100.0)	1,526	(100.0)

Braking versus non-braking vehicles in frontal impacts differed with respect to the AIS ratings for the severest injury to the involved pedestrian. Non-braking vehicles inflicted a greater percentage of AIS 5-6 injuries than braking vehicles, and a proportionately lower frequency of low severity injuries (AIS 1-3). (See Table 4-25.)

TABLE 4-25. - SEVEREST INJURY BY VEHICLE BRAKING - FRONTAL IMPACTS

AIS	Vehicle Braking Yes	%	No	%	Total	%
1-3	909	(87.7)	267	(69.7)	1,176	(82.8)
4	60	(5.8)	27	(7.1)	87	(6.1)
5,6	68	(6.6)	89	(23.2)	157	(11.1)
TOTAL	1,037	(100.0)	383	(100.0)	1,420	(100.0)

Pedestrians struck by non-braking vehicles suffered injuries to the head and neck, abdomen or chest area, more frequently than people struck by braking vehicles. Percentages were slightly higher in the braking vehicle category for pedestrians whose severest injury occurred to the face, pelvic-hip area or the extremities, as shown in Table 4-26.

TABLE 4-26. - BODY REGION-SEVEREST INJURY BY VEHICLE BRAKING - FRONTAL IMPACTS

	Vehicle Braking					
Body Area	Yes	%	No	%	Total	%
Head & Neck	251	(23.6)	129	(33.1)	380	(26.2)
Face	122	(11.5)	20	(5.1)	142	(9.8)
Chest	33	(3.1)	21	(5.4)	54	(3.7)
Abdomen	41	(3.6)	36	(9.2)	77	(5.3)
Back	29	(2.7)	11	(2.8)	40	(2.8)
Pelvic-Hip	89	(8.4)	20	(5.1)	109	(7.5)
Upper Extremities	127	(11.9)	35	(9.0)	162	(11.1)
Lower Extremities	370	(34.8)	118	(30.3)	488	(33.6)
Whole Body	1	(0.1)	0		1	(0.1)
Unknown	2	(---)	1	(---)	3	(---)
TOTAL	1,065	(100.0)	391	(100.0)	1,456	(100.0)

The lesions associated with the severest injury to the pedestrian are presented in Table 4-27. Fractures and lacerations occurred more frequently when the driver did not brake, than when brakes were applied. Abrasions and contusions were more frequent in cases involving braking versus non-braking vehicles. Overall, however, most injury types occurred in approximately the same proportions for both categories.

TABLE 4-27. - SEVEREST INJURY BY VEHICLE BRAKING - FRONTAL IMPACTS

	Vehicle Braking					
Lesion	Yes	%	No	%	Total	%
Abrasion	160	(15.3)	32	(8.3)	192	(13.4)
Contusion	332	(31.8)	80	(20.8)	412	(28.8)
Dislocation	17	(1.6)	7	(1.8)	24	(1.7)
Fracture	215	(20.6)	96	(24.9)	311	(21.7)
Hemorrhage	6	(0.6)	4	(1.0)	10	(0.7)
Concussion	100	(9.6)	37	(9.6)	137	(9.6)
Laceration	93	(8.9)	69	(17.9)	162	(11.3)
Amputation	0		3	(0.8)	3	(0.2)
Crushing	6	(0.6)	7	(1.8)	13	(0.9)
Pain	88	(8.4)	26	(6.8)	114	(8.0)
Rupture	3	(0.3)	8	(2.1)	11	(0.8)
Sprain	13	(1.2)	6	(1.6)	19	(1.3)
Avulsion	1	(0.1)	0		1	(0.1)
Other	11	(1.1)	10	(2.6)	21	(1.5)
Unknown	20	(---)	6	(---)	26	(---)
TOTAL	1,065	(100.0)	391	(100.0)	1,456	(100.0)

The sources of the pedestrian's severest injury were quite similar for both braking and non-braking vehicles. For braking vehicles, injuries caused by the pavement, front bumper and grille were more frequent than for non-braking vehicles. Injuries caused by energy transfer, windshield glass and trim and tires were more frequent when pedestrians were struck by non-braking vehicles than by braking vehicles. (See Table 4-28.)

TABLE 4-28. - SOURCE OF SEVEREST INJURY BY VEHICLE BRAKING - FRONTAL IMPACTS

Injury Source	Vehicle Braking Yes	%	No	%	Total	%
Front Bumper Assembly	253	(26.1)	77	(23.3)	330	(25.4)
Grille, Headlights	82	(8.5)	17	(5.2)	99	(7.6)
Hood Face	82	(8.5)	30	(9.1)	112	(8.6)
Hood Top	82	(8.5)	30	(9.1)	112	(8.6)
Cowl, Wiper Blade Mount	3	(0.3)	0		3	(0.2)
Front Fender	46	(4.7)	19	(5.8)	65	(5.0)
Radio Antenna	1	(0.1)	0		1	(0.1)
Windshield & Trim	16	(1.7)	20	(6.1)	36	(2.8)
Roof	0		2	(0.6)	2	(0.2)
Tires/Wheels	7	(0.7)	14	(4.2)	21	(1.6)
Undercarriage	1	(0.1)	5	(1.5)	6	(0.5)
Energy Transfer	51	(5.3)	28	(8.5)	79	(6.1)
Accessories/Ornaments	3	(0.3)	6	(1.8)	9	(0.7)
Other Pedestrian	1	(0.1)	1	(0.3)	2	(0.2)
Pavement	335	(34.6)	78	(23.6)	413	(31.8)
Other	5	(0.5)	2	(0.6)	7	(0.5)
Non-Contact Injury Source	1	(0.1)	1	(0.3)	2	(0.2)
Unknown	96	(---)	61	(---)	157	(---)
TOTAL	1,065	(100.0)	391	(100.0)	1,456	(100.0)

4.8 Injury Source and Type

The initial pedestrian contact with a vehicle and the subsequent contacts, interactions and injury patterns are influenced by the multiple variables present in the accident sequence. The age and size of the pedestrian combines with other accident factors to contribute to the sequence of events that follow the first contact.

In order to focus the data analysis, a number of specific questions relating to injury severity will be addressed. In attempting to answer these questions, two pedestrian groups will be studied, those 10 years of age or younger and those over that age. These groups were chosen to be representative of the types of anthropomorphic dummies being used in pedestrian impact tests conducted by NHTSA.

For an overview of adult versus child (over 10 or 10 years of age or less, respectively) susceptibility to injury with respect to the individual vehicle components and environmental surfaces, injuries are described first using the highest AIS injury to each body area. This will produce different results than examining all injuries because the most frequent injury producing contact will not necessarily inflict the severest injuries.

Initially, only injuries with an AIS of 3 or greater were analyzed; however, as was expected, this typically reduced the frequency of pavement contacts and proportionately increased the percentage of all other injury sources. Thus, it appeared preferable to study the highest AIS to each body area followed by an analysis of all injuries to each body area examining, in each instance, the injury sources and the types of injuries associated with each injury source. Lower extremity and life-threatening injuries are then analyzed separately because they represent important and frequent pedestrian injuries. The results are presented in the sub-sections which follow.

Highest AIS to Each Body Area by Injury Source - Contact with the pavement results in the largest proportion of head, neck, face, upper limb and chest injuries for children. With the exception of the chest, the same body areas are most frequently injured by the pavement for adults, as well. Children receive a considerably larger proportion of their injuries to every body area from the pavement, than do adults (Tables 4-29, 4-30). The prominence of pavement related injuries for children occurs because a child is thrown or knocked to the ground far more often than an adult when struck by a motor vehicle (refer to Tables 4-17, 4-18).

The front bumper is responsible for most lower limb injuries to both children and adults (Tables 4-29, 4-30). Pavement injuries are far less frequent among adults, however, most pelvic-hip injuries and a high proportion of abdomen injuries to children (but not adults) are also caused by the bumper. Among children, the entire torso -- chest, abdomen, pelvic-hip -- is frequently injured by the vehicle grille area. Adults frequently sustain abdomen and pelvic-hip injuries from the grille but, because they are taller, rarely sustain chest injuries from this source. Other rather frequent vehicular sources of injury for children are the hood face, headlight and front fender for the torso and upper limb injuries, and the hood face or top for head, neck or face injuries. Only one of the severest injuries to children resulted from contact with the windshield or glass.

Among adults, the source of the severest injury to each body area differs considerably from that for children, and most of the differences are size-related. Adults sustain fewer injuries from the pavement than do children (33.8 and 48.6 percent, respectively). Injuries caused by the bumper are confined almost exclusively to the lower extremities. The grille and headlight are a source of injury for the abdomen, pelvic-hip area, primarily. The hood face and front fender injures the chest in addition to the latter two body areas. The hood top is a frequent source of injury to the head, torso and upper limbs. The windshield area is a rather frequent source of head, neck and face injuries.

In summary, the picture that emerges when studying the severest injury to various body areas for children and adults is very much related to pedestrian size. Adults experience more serious injuries than children (refer to Tables 4-11, 4-12) and sustain a larger proportion of their injuries from

TABLE 4-29. - SEVEREST INJURY TO EACH BODY AREA (CHILDREN)

	Head & Neck	Face	Chest	Abdomen	Pelvic-Hip	Upper Extremities	Lower Extremities	Whole Body	Total
Front Bumper	2 (0.7)	3 (0.8)	6 (5.7)	16 (16.8)	37 (27.2)	10 (2.9)	187 (40.3)	0	261 (14.4)
Grille, Head-lights	11 (3.7)	9 (2.5)	29 (27.4)	34 (35.8)	34 (25.0)	41 (11.7)	1 (0.2)	0	159 (8.8)
Hood Face	15 (5.0)	10 (2.8)	14 (13.2)	6 (6.3)	15 (11.0)	23 (6.6)	4 (0.9)	0	87 (4.8)
Hood Top	39 (13.0)	37 (10.3)	5 (4.7)	0	0	14 (4.0)	0	0	95 (5.2)
Hood Cowl, Wiper Blade Mount	0	0	0	0	0	0	0	0	0
Front Fender	16 (5.3)	26 (7.2)	10 (9.4)	6 (6.3)	16 (11.8)	19 (5.4)	24 (5.2)	0	117 (6.5)
Radio Antenna	0	0	0	0	0	0	0	0	0
Windshield & Trim	0	0	0	0	0	1 (0.3)	0	0	1 (0.1)
Roof	0	0	0	0	0	0	0	0	0
A-Pillar	3 (1.0)	3 (0.8)	0	0	0	0	0	0	6 (0.3)
B,C, or D-Pillar	1 (0.3)	2 (0.6)	0	0	0	0	0	0	3 (0.2)
Side Rail	0	1 (0.3)	0	0	0	0	0	0	1 (0.1)
Door & Lower Side	3 (1.0)	6 (1.7)	1 (0.9)	1 (1.1)	2 (1.5)	7 (2.0)	11 (2.4)	0	31 (1.7)
Rear Fender, Quarter Panel	0	1 (0.3)	2 (1.9)	3 (3.2)	2 (1.5)	6 (1.7)	6 (1.3)	0	20 (1.1)
Tailgate, Trunk Deck	0	0	0	0	0	0	0	0	0
Rear Bumper	0	0	0	0	0	0	3 (0.6)	0	3 (0.2)
Tires, Wheels	4 (1.3)	2 (0.6)	3 (2.8)	3 (3.2)	0	3 (0.9)	45 (9.7)	0	60 (3.3)
Undercarriage	1 (0.3)	1 (0.3)	1 (0.9)	1 (1.1)	0	3 (0.9)	1 (0.2)	0	8 (0.4)
Energy Transfer	13 (4.3)	2 (0.6)	1 (0.9)	4 (4.2)	2 (1.5)	2 (0.6)	19 (4.1)	0	43 (2.4)
Access., Ornaments	6 (2.0)	6 (1.7)	3 (2.8)	1 (1.1)	0	11 (3.1)	2 (0.4)	0	29 (1.6)
Other Ped. or Veh.	0	0	0	0	0	0	0	0	0
Pavement	185 (61.5)	249 (69.2)	31 (29.2)	20 (21.1)	27 (19.9)	208 (59.4)	161 (34.7)	1 (100.0)	882 (48.6)
Other	2 (0.7)	2 (0.6)	0	0	1 (0.7)	2 (0.6)	0	0	7 (0.4)
Underhood Component	0	0	0	0	0	0	0	0	0
Non-Contact Inj. Source	0	0	0	0	0	0	0	0	0
Unknown	32 (---)	27 (---)	15 (---)	15 (---)	14 (---)	35 (---)	33 (---)	0 (---)	171 (---)
TOTAL	333 (16.8)	387 (19.5)	121 (6.1)	110 (5.5)	150 (7.6)	385 (19.4)	497 (25.1)	1 (0.1)	1984 (100.0)

TABLE 4-30. - SEVEREST INJURY TO EACH BODY AREA (ADULT)

	Head and Neck	Face	Chest	Abdomen	Pelvic-Hip	Upper Extremities	Lower Extremities	Whole Body	Total
Front Bumper	2 (0.4)	1 (0.3)	1 (0.5)	1 (0.6)	3 (0.9)	1 (0.2)	401 (49.4)	1 (33.3)	411 (14.4)
Grille/Headlights	0	1 (0.3)	1 (0.5)	33 (21.2)	94 (28.4)	18 (3.2)	44 (5.4)	0	191 (6.7)
Hood Face	1 (0.2)	1 (0.3)	21 (10.0)	34 (21.8)	92 (27.8)	28 (4.9)	41 (5.0)	0	218 (7.7)
Hood Top	45 (9.6)	47 (15.8)	67 (31.9)	22 (14.1)	18 (5.4)	115 (20.2)	2 (0.2)	0	316 (11.1)
Cowl/Wiper Blade Mount	9 (1.9)	4 (1.3)	0	0	0	5 (0.9)	0	0	18 (0.6)
Front Fender	14 (3.0)	7 (2.3)	16 (7.6)	23 (14.7)	39 (11.8)	24 (4.2)	60 (7.4)	0	183 (6.4)
Radio Antenna	1 (0.2)	3 (1.0)	2 (1.0)	0	0	2 (0.4)	0	0	8 (0.3)
Windshield & Trim	66 (14.1)	33 (11.1)	4 (1.9)	0	0	26 (4.6)	0	0	129 (4.5)
Roof	5 (1.1)	1 (0.3)	1 (0.5)	1 (0.6)	0	2 (0.4)	0	0	10 (0.4)
A-Pillar	1 (0.2)	1 (0.3)	2 (1.0)	1 (0.6)	0	4 (0.7)	0	0	9 (0.3)
B,C,or D Pillar	0	0	2 (1.0)	0	0	3 (0.5)	0	0	5 (0.2)
Side Rail	1 (0.2)	0	1 (0.5)	0	0	4 (0.7)	0	0	6 (0.2)
Door & Lower Side	2 (0.4)	0	2 (1.0)	2 (1.3)	7 (2.1)	4 (0.7)	21 (2.6)	0	38 (1.3)
Rear Fender/ Quarter Panel	0	0	1 (0.5)	0	8 (2.4)	6 (1.1)	13 (1.6)	0	28 (1.0)
Tailgate/ Trunk Deck	0	1 (0.3)	0	1 (0.6)	6 (1.8)	0	1 (0.1)	0	9 (0.3)
Rear Bumper	0	0	0	1 (0.6)	1 (0.3)	0	9 (1.1)	0	11 (0.4)
Tires/Wheels	4 (0.9)	1 (0.3)	8 (3.8)	7 (4.5)	3 (0.9)	4 (0.7)	28 (3.4)	0	55 (1.9)
Undercarriage	3 (0.6)	1 (0.3)	5 (2.4)	2 (1.3)	0	3 (0.5)	1 (0.1)	0	15 (0.5)
Energy Transfer	61 (13.0)	2 (0.7)	10 (4.8)	8 (5.1)	2 (0.6)	5 (0.9)	46 (5.7)	1 (33.3)	135 (4.7)
Accessories/ Ornaments	6 (1.3)	8 (2.7)	12 (5.7)	2 (1.3)	3 (0.9)	28 (4.9)	2 (0.2)	0	61 (2.1)
Other/Pedestrians or Vehicles	1 (0.2)	2 (0.7)	1 (0.5)	0	0	2 (0.4)	1 (0.1)	0	7 (0.2)
Pavement	241 (51.4)	178 (59.7)	51 (24.3)	17 (10.9)	54 (16.3)	281 (49.4)	141 (17.4)	1 (33.3)	964 (33.8)
Other	5 (1.1)	6 (2.0)	2 (1.0)	0	1 (0.3)	3 (0.5)	1 (0.1)	0	18 (0.6)
Underhood Component	0	0	0	0	0	1 (0.2)	0	0	1 (0.0)
Non-Contact Injury Source	1 (0.2)	0	0	1 (0.6)	0	0	0	0	2 (0.1)
Unknown	59	33	31	24	44	68	93	2	354
TOTAL	528 (16.5)	331 (10.3)	241 (7.5)	180 (5.6)	375 (11.7)	637 (19.9)	905 (28.3)	5 (0.2)	3,202 (100.0)

vehicle contacts rather than the pavement. Injuries from the front (face area from bumper to hood top) of the vehicle generally result in injuries to the abdomen, pelvic-hip and lower limbs for adults and to the entire torso and both lower and upper limbs for children. Few children were able to contact the hood top, except with the head, neck and face, whereas the hood top is a frequent source of injury to the head, neck, torso and upper extremities of adults. The windshield area also is contacted rather frequently by adults.

All Injuries to Each Body Area by Injury Source - Injuries to the lower extremities are the most frequent injuries to both children and adults, representing, respectively, 26.3 and 32.4 percent of all injuries (Tables 4-31, 4-32). Although leg injuries are frequent, they are rarely life-threatening: only 2.64 percent of children's leg injuries, and 6.29 percent of adults' injuries, were rated as high as AIS 4. Injuries to the face, upper extremities and head and neck rank next, in that order, for children. For adults the ranking is: upper extremities, head and neck and face. The general patterns for all injuries to children and adults is similar to that for the severest injuries that they sustained.

Additional details concerning specific leg area injured are provided in Tables 4-31, 4-32. The frequency of injury is similar in magnitude for children and adults for all leg areas and ranges from about 19 to 25 percent for most areas. The ankle-foot area is injured least often, 12.6 percent for children and 10.6 percent for adults.

Injuries to the knee and lower leg area of children are most often caused by the pavement; for adults, the source is the front bumper. Thigh injuries for children are most often caused by the front bumper (72%), while for adults, these injuries are caused by the front bumper, grille, hood face and front fender (percentages range from about 14 to 25 percent for these components). The effect of differences in pedestrian size relative to component heights is clearly evident in these data.

TABLE 4-31. - ALL INJURIES TO EACH BODY AREA BY INJURY SOURCE - CHILDREN

	Head & Neck	Face	Chest	Abdomen	Upper Extremities	Whole Body
Front Bumper	5 (1.1)	4 (0.6)	6 (4.1)	22 (19.1)	14 (2.7)	0
Grille, Headlights	19 (4.3)	12 (1.9)	40 (27.6)	43 (37.4)	53 (10.2)	0
Hood Face	22 (5.0)	13 (2.1)	19 (13.1)	6 (5.2)	30 (5.7)	0
Hood Top	52 (11.9)	65 (10.5)	6 (4.1)	0	26 (5.0)	0
Hood Cowl, Wiper Blade Mount	0	0	0	0	0	0
Front Fender	29 (6.6)	41 (6.6)	19 (13.1)	7 (6.1)	25 (4.8)	0
Radio Antenna	0	0	0	0	0	0
Windshield & Trim	0	0	0	0	1 (0.2)	0
Roof	0	0	0	0	0	0
A-Pillar	4 (0.9)	4 (0.6)	0	0	0	0
B,C, or D-Pillar	1 (0.2)	2 (0.3)	0	0	0	0
Side Rail	0	1 (0.2)	0	0	0	0
Door & Lower Side	3 (0.7)	9 (1.5)	2 (1.4)	1 (0.9)	9 (1.7)	0
Rear Fender, Quarter Panel	0	1 (0.2)	2 (1.4)	4 (3.5)	10 (1.9)	0
Tailgate, Trunk Deck	0	3 (0.5)	0	0	0	0
Rear Bumper	0	0	0	0	0	0
Tires, Wheels	6 (1.4)	4 (0.6)	6 (4.1)	4 (3.5)	5 (1.0)	0
Undercarriage	1 (0.2)	4 (0.6)	3 (2.1)	2 (1.7)	5 (1.0)	0
Energy Transfer	26 (5.9)	2 (0.3)	1 (0.7)	5 (4.3)	2 (0.4)	0
Access., Ornaments	9 (2.1)	8 (1.3)	4 (2.8)	1 (0.9)	14 (2.7)	0
Other Ped. or Veh.	0	1 (0.2)	0	0	0	0
Pavement	257 (58.8)	441 (71.4)	37 (25.5)	20 (17.4)	326 (62.5)	1 (100.0)
Other	3 (0.7)	3 (0.5)	0	0	2 (0.4)	0
Underhood Component	0	0	0	0	0	0
Non-Contact Inj. Source	0	0	0	0	0	0
Unknown	62	50	21	16	56	0
TOTAL	499	668	166	131	578	1
% of All Injuries	16.5	22.1	5.5	4.3	19.1	0.0

TABLE 4-31. - (CONTINUED)

	Knee	Lower Leg	Ankle-Foot	Thigh	General Lower Extremities	Pelvic-Hip	Total
Front Bumper	38 (17.5)	46 (27.4)	1 (0.9)	159 (72.3)	2 (10.0)	41 (25.0)	338 (12.3)
Grille, Headlights	0	0	0	5 (2.3)	0	39 (23.8)	211 (7.7)
Hood Face	0	1 (0.6)	0	5 (2.3)	0	17 (10.4)	113 (4.1)
Hood Top	0	0	0	0	0	0	149 (5.4)
Hood Cowl, Wiper Blade Mount	0	0	0	0	0	0	0
Front Fender	13 (6.0)	8 (4.8)	0	11 (5.0)	0	19 (11.6)	172 (6.3)
Radio Antenna	0	0	0	0	0	0	0
Windshield & Trim	0	0	0	0	0	0	1 (0.0)
Roof	0	0	0	0	0	0	0
A-Pillar	0	0	0	0	0	0	8 (0.3)
B,C, or D-Pillar	0	0	0	0	0	0	3 (0.1)
Side Rail	0	0	0	0	0	0	1 (0.0)
Door & Lower Side	7 (3.2)	9 (5.4)	2 (1.8)	2 (0.9)	0	2 (1.2)	46 (1.7)
Rear Fender, Quarter Panel	4 (1.8)	2 (1.2)	0	4 (1.8)	0	3 (1.8)	30 (1.1)
Tailgate, Trunk Deck	0	0	0	0	0	0	3 (0.1)
Rear Bumper	0	1 (0.6)	0	3 (1.4)	0	0	4 (0.1)
Tires, Wheels	4 (1.8)	24 (14.3)	38 (33.6)	7 (3.2)	0	0	98 (3.6)
Undercarriage	0	1 (0.6)	0	0	0	0	16 (0.6)
Energy Transfer	7 (3.2)	13 (7.7)	10 (8.8)	0	0	3 (1.8)	69 (2.5)
Access., Ornaments	0	1 (0.6)	0	2 (0.9)	0	0	39 (1.4)
Other Ped. or Veh.	0	0	0	0	0	0	1 (0.0)
Pavement	144 (66.4)	62 (36.9)	62 (54.9)	21 (9.5)	18 (90.0)	39 (23.8)	1,428 (52.1)
Other	0	0	0	1 (0.5)	0	1 (0.6)	10 (0.4)
Underhood Component	0	0	0	0	0	0	0
Non-Contact Inj. Source	0	0	0	0	0	0	0
Unknown	16	16	10	10	5	18	280
TOTAL	233	184	123	230	25	182	3,020
% All Injuries to Lower Extremities & Pelvic-Hip	23.8	18.8	12.6	23.5	2.6	18.6	
% of All Injuries	7.7	6.1	4.1	7.6	0.8	6.0	100.0

TABLE 4-32. - ALL INJURIES TO EACH BODY AREA BY INJURY SOURCE - ADULTS

	Head & Neck	Face	Chest	Abdomen	Upper Extremities	Whole Body
Front Bumper	4 (0.5)	1 (0.2)	3 (0.8)	1 (0.4)	1 (0.1)	1 (33.3)
Grille, Headlights	0	3 (0.6)	1 (0.2)	64 (24.8)	25 (2.9)	0
Hood Face	1 (0.1)	2 (0.4)	45 (12.4)	58 (22.5)	39 (4.5)	0
Hood Top	89 (11.4)	75 (14.3)	124 (34.1)	35 (13.6)	162 (18.7)	0
Hood Cowl, Wiper Blade Mount	13 (1.7)	4 (0.8)	0	0	7 (0.8)	0
Front Fender	29 (3.7)	14 (2.7)	28 (7.7)	38 (14.7)	36 (4.2)	0
Radio Antenna	5 (0.6)	4 (0.8)	2 (0.5)	0	3 (0.3)	0
Windshield & Trim	113 (14.5)	63 (12.0)	9 (2.5)	0	37 (4.3)	0
Roof	8 (1.0)	7 (1.3)	2 (0.5)	1 (0.4)	2 (0.2)	0
A-Pillar	2 (0.3)	2 (0.4)	3 (0.8)	1 (0.4)	6 (0.7)	0
B,C, or D-Pillar	0	0	2 (0.5)	0	5 (0.6)	0
Side Rail	1 (0.1)	0	1 (0.2)	0	7 (0.8)	0
Door & Lower Side	3 (0.4)	0	4 (1.1)	4 (1.6)	7 (0.8)	0
Rear Fender, Quarter Panel	0	0	1 (0.3)	0	6 (0.7)	0
Tailgate, Trunk Deck	0	4 (0.8)	0	1 (0.4)	0	0
Rear Bumper	0	0	0	1 (0.4)	0	0
Tires, Wheels	6 (0.8)	1 (0.2)	23 (6.3)	10 (3.9)	6 (0.7)	0
Undercarriage	6 (0.8)	1 (0.2)	16 (4.4)	6 (2.3)	3 (0.3)	0
Energy Transfer	109 (14.0)	2 (0.4)	12 (3.3)	12 (4.7)	7 (0.8)	1 (33.3)
Access., Ornaments	7 (0.9)	14 (2.7)	14 (3.8)	2 (0.8)	40 (4.6)	0
Other Péd. or Veh.	1 (0.1)	2 (0.4)	2 (0.5)	2 (0.8)	2 (0.2)	0
Pavement	369 (47.4)	320 (60.8)	70 (19.2)	21 (8.1)	461 (53.2)	1 (33.3)
Other	12 (1.5)	7 (1.3)	2 (0.5)	0	3 (0.3)	0
Underhood Component	0	0	0	0	2 (0.2)	0
Non-Contact Inj. Source	1 (0.1)	0	0	1 (0.4)	0	0
Unknown	96	58	44	58	109	3
TOTAL	875	584	408	316	976	6
% of All Injuries	16.3	10.9	7.6	5.9	18.2	0.1

TABLE 4-32. - (CONTINUED)

	Knee	Lower Leg	Ankle-Foot	Thigh	General Lower Extremities	Pelvic-Hip	Total
Front Bumper	210 (48.7)	362 (70.8)	9 (4.4)	80 (21.1)	14 (34.1)	3 (0.7)	689 (14.4)
Grille, Headlights	2 (0.5)	6 (1.2)	1 (0.5)	94 (24.7)	2 (4.9)	111 (27.5)	309 (6.5)
Hood Face	0	2 (0.4)	0	75 (19.7)	2 (4.9)	116 (28.7)	340 (7.1)
Hood Top	2 (0.5)	0	0	0	1 (2.4)	22 (5.4)	510 (10.7)
Hood Cowl, Wiper Blade Mount	0	0	0	0	0	0	24 (0.5)
Front Fender	19 (4.4)	22 (4.3)	1 (0.5)	54 (14.2)	3 (7.3)	49 (12.1)	293 (6.1)
Radio Antenna	0	0	0	0	0	0	14 (0.3)
Windshield & Trim	0	0	0	1 (0.3)	0	0	223 (4.7)
Roof	0	0	0	0	0	0	20 (0.4)
A-Pillar	0	0	0	0	0	0	14 (0.3)
B,C, or D-Pillar	0	0	0	0	0	0	7 (0.1)
Side Rail	0	0	0	0	0	0	9 (0.2)
Door & Lower Side	10 (2.3)	13 (2.5)	1 (0.5)	15 (3.9)	0	7 (1.7)	64 (1.3)
Rear Fender, Quarter Panel	12 (2.8)	5 (1.0)	1 (0.5)	8 (2.1)	1 (2.4)	8 (2.0)	42 (0.9)
Tailgate, Trunk Deck	0	0	0	1 (0.3)	0	7 (1.7)	13 (0.3)
Rear Bumper	7 (1.6)	5 (1.0)	0	3 (0.8)	0	1 (0.2)	17 (0.4)
Tires, Wheels	4 (0.9)	11 (2.2)	25 (12.1)	1 (0.3)	0	4 (1.0)	91 (1.9)
Undercarriage	0	2 (0.4)	2 (1.0)	0	1 (2.4)	0	37 (0.8)
Energy Transmittal	10 (2.3)	20 (3.9)	57 (27.7)	2 (0.5)	1 (2.4)	2 (0.5)	235 (4.9)
Access., Ornaments	0	1 (0.2)	0	5 (1.3)	0	3 (0.7)	86 (1.8)
Other Ped. or Veh.	0	0	0	2 (0.5)	0	0	11 (0.2)
Pavement	155 (36.0)	62 (12.1)	107 (51.9)	39 (10.3)	15 (36.6)	70 (17.3)	1,690 (35.4)
Other	0	0	2 (1.0)	0	1 (2.4)	1 (0.2)	28 (0.6)
Underhood Component	0	0	0	0	0	0	2 (0.0)
Non-Contact Inj. Source	0	0	0	0	0	0	2 (0.0)
Unknown	39	50	27	39	10	56	589
TOTAL	470	561	233	419	51	460	5,359
% All Injuries to Lower Extremities & Pelvic-Hip	21.4	25.6	10.6	19.1	2.3	21.0	
% of All Injuries	8.8	10.5	4.3	7.8	1.0	8.6	100.0

Lower Extremity and Pelvic-Hip Injuries by Source and Type of Lesion - Tables 4-33 and 4-34 describe the types of lesions sustained by body areas that contacted various components. Only major injury sources and associated injuries are tabulated; thus, the last two columns do not necessarily add to 100 percent.

The pavement ranked first as the source of injuries to children for all body regions but the pelvic-hip and thigh; for those body regions the front bumper is first and the pavement second. The front bumper generally ranks second for most other regions except ankle-foot, for which the tires/wheels category is second. For all lower extremity regions, the pavement contact produced abrasions and contusions only. The front bumper on the other hand often produced fractures to the lower leg, pelvic-hip and thigh regions.

Among adults, a vehicle component is the leading source of injury for four of the six regions listed. Pavement ranked first for ankle-foot and general extremity injury. Vehicle contact resulted in fractures for all leg regions except the knee area. This contrasts markedly with the results for children where the front bumper (ranking second to the pavement) is one of the few vehicle components that produce fractures and then only to the lower leg, pelvic-hip and thigh areas. Fractures are more frequent among the adults than among the children.

The pavement primarily produced abrasions and contusions: 93 percent of the lesions associated with leg contacts to the pavement are abrasions and contusions for children and, for adults, 85 percent. The front bumper also is associated with a large percentage of abrasions and contusions; however, fractures to the lower extremities rank as the second most common lesion caused by the bumper. With regard to these injuries, Table 4-31 showed that front bumper contacts with children extend beyond the lower extremities to include the pelvic-hip and abdominal body areas while for adults, contacts with the front bumper are almost exclusively confined to the lower part of the lower extremities.

TABLE 4-33. - LOWER EXTREMITY AND PELVIC-HIP INJURIES BY SOURCE AND TYPE OF LESION - CHILDREN

% of All Injuries to Lower Extremities	Body Region	% of All Injuries to Body Region	Source	% of Injuries by Source	Lesion
23.8	Knee	66.4	Pavement	73.6	Abrasion
				18.1	Contusion
		17.5	Front Bumper	63.2	Contusion
				26.3	Abrasion
		6.0	Front Fender	61.5	Contusion
				23.1	Pain
18.8	Lower Leg	36.9	Pavement	61.3	Abrasion
				27.4	Contusion
		27.4	Front Bumper	47.8	Contusion
				23.9	Fracture
				21.7	Pain
		14.3	Tires/Wheels	45.8	Fracture
				25.0	Abrasion
				16.7	Contusion
		7.7	Energy Transfer	61.5	Fracture
				30.8	Pain
18.6	Pelvic-Hip	25.0	Front Bumper	53.7	Contusion
				24.4	Pain
				14.6	Fracture
		23.8	Pavement	46.2	Abrasion
				38.5	Contusion
		23.8	Grille/Headlights	59.0	Contusion
				23.1	Pain
				15.4	Abrasion
		10.4	Hood Face	88.2	Contusion
				11.8	Abrasion & Pain

TABLE 4-33. - (CONTINUED)

% of All Injuries to Lower Extremities	Body Region	% of All Injuries to Body Region	Source	% of Injuries by Source	Lesion
12.6	Ankle-Foot	54.9	Pavement	79.0	Abrasion
				14.5	Contusion
		33.6	Tires/Wheels	36.8	Abrasion
				34.2	Contusion
				10.5	Pain
		8.8	Energy Transfer	50.0	Pain
				30.0	Other
23.5	Thigh	72.3	Front Bumper	44.0	Contusion
				32.7	Fracture
				15.1	Pain
		9.5	Pavement	85.7	Abrasion
				14.3	Contusion
		5.0	Front Fender	63.6	Pain
				36.4	Contusion
2.6	Lower Extremity (General)	90.0	Pavement	83.3	Abrasion
				16.7	Contusion
		10.0	Front Bumper	100.0	Contusion

TABLE 4-34. - LOWER EXTREMITY AND PELVIC-HIP INJURIES BY SOURCE AND TYPE OF LESION - ADULTS

% of All Injuries to Lower Extremities	Body Region	% of All Injuries to Body Region	Source	% of Injuries By Source	Lesion
21.4	Knee	48.7	Front Bumper	48.6	Contusion
				14.8	Abrasion
				12.4	Pain
		36.0	Pavement	74.2	Abrasion
				16.8	Contusion
25.6	Lower Leg	71.0	Front Bumper	42.5	Fracture
				31.8	Contusion
		12.2	Pavement	59.7	Abrasion
				17.7	Contusion
				14.5	Laceration
21.0	Pelvic-Hip	28.7	Hood Face	35.3	Fracture
				27.6	Contusion
				14.7	Pain
		27.5	Grille/Headlights	36.9	Fracture
				31.5	Contusion
				19.8	Pain
		17.3	Pavement	37.1	Contusion
				27.1	Pain
				27.1	Abrasion
10.6	Ankle-Foot	51.9	Pavement	54.2	Abrasion
				29.9	Contusion
				6.5	Fracture
		27.7	Energy Transfer	45.6	Pain
				24.6	Fracture
				21.1	Sprain
		12.1	Tires/Wheels	44.0	Contusion
				24.0	Fracture
				12.0	Abrasion
				12.0	Pain

TABLE 4-34. - (CONTINUED)

% of All Injuries to Lower Extremities	Body Region	% of All Injuries to Body	Source	% of Injuries By Source	Lesion
19.1	Thigh	24.7	Grille/Headlights	50.0	Contusion
				20.2	Fracture
				13.8	Pain
		21.1	Front Bumper	46.3	Contusion
				38.8	Fracture
				8.8	Pain
		19.7	Hood Face	56.0	Contusion
				17.3	Fracture
				16.0	Pain
		10.3	Pavement	41.0	Abrasion
				38.5	Contusion
2.3	Lower Extremity (General)	36.6	Pavement	53.3	Abrasion
				26.7	Pain
				20.0	Contusion
		24.7	Front Bumper	57.1	Contusion
				21.4	Abrasion

Lower Extremity Fractures, Injury Source and Impact Speed by Pedestrian Age - An initial examination of lower extremity lesions and the associated injury sources suggests the possibility that there is a difference between adults and children with respect to susceptibility to leg fractures. In the previous sections when "all injuries" to the lower extremities of children were grouped, it was found that they resulted more often from pavement contact than from front bumper contact (refer to Table 4-31). Tabulation of the highest AIS to each body area showed that injuries were produced somewhat more often by the bumper, 40.3 versus 34.7 percent from the pavement (Table 4-29). Adults, however, experienced more injuries to their lower extremities from the front bumper than from the pavement (43.0%* and 24.1% respectively of all leg injuries) and, of more importance, 49.4 percent of the highest AIS injuries to adult lower extremities were from front bumper contact while 17.4 percent were from pavement contact (refer to Table 4-30).

Table 4-35 (injury source for lower extremity fractures in frontal impacts), emphasizes the importance of the front bumper as a source of leg fractures and the relatively small proportion of these lesions that are associated with the pavement or, for this matter, with other vehicle components.

---

* Table 4-32: $\frac{\text{Sum of injuries to lower extremities by bumper}}{\text{(Total - Unknown Category)}}$ = 43.0%

TABLE 4-35. - INJURY SOURCE BY PEDESTRIAN AGE FOR LOWER EXTREMITY FRACTURES IN FRONTAL IMPACTS

	Pedestrian Age					
Injury Source	≤ 10	%	> 10	%	Total	%
Front Bumper	63	(85.1)	194	(69.0)	257	(72.4)
Grille/Headlights	0		21	(7.5)	21	(5.9)
Hood Face	1	(1.4)	13	(4.6)	14	(3.9)
Front Fender	0		12	(4.3)	12	(3.4)
Tires/Wheels	4	(5.4)	4	(1.4)	8	(2.3)
Undercarriage	1	(1.4)	0		1	(0.3)
Energy Transfer	5	(6.8)	27	(9.6)	32	(9.0)
Pavement	0		9	(3.2)	9	(2.5)
Other	0		1	(0.4)	1	(0.3)
Unknown	3		21		24	
TOTAL	77	(100.0)	302	(100.0)	379	(100.0)

One final consideration with respect to lower extremity fractures is the impact speed at which the pedestrian accidents involving leg fractures occur. Table 4-36 provides data for leg fractures by calculated impact speeds and pedestrian age in frontal impacts. The majority of impact speeds for this injury type are above 10 MPH, 76.3 percent for children and 87.6 percent for adult pedestrians. For both age groups, approximately half of the impacts occurred at speeds above 15 MPH.

Adult susceptibility to leg fractures is associated with the fact that a greater proportion of their leg injuries resulted from contact with the front bumper rather than the pavement, and front bumper contacts produce a larger proportion of leg fractures than do pavement contacts. Accidents involving leg fractures had a larger proportion of adults than children in the speed ranges above 10 MPH.

TABLE 4-36. - LOWER EXTREMITY FRACTURES BY IMPACT SPEED AND PEDESTRIAN AGE IN FRONTAL IMPACTS

	Pedestrian Age					
Speed - MPH	≤10	%	>10	%	Total	%
0-5	0	---	1	(1.4)	1	(0.9)
6-10	9	(23.7)	8	(11.0)	17	(15.3)
11-15	10	(26.3)	25	(34.2)	35	(31.5)
16-30	17	(44.7)	25	(34.2)	42	(37.8)
Above 30	2	(5.3)	14	(19.2)	16	(14.4)
TOTAL	38	(100.0)	73	(100.0)	111	(100.0)

4.9 Critical and Fatal Pedestrian Head, Neck Injuries

Although the lower extremities are the most frequent body regions injured for both adults and children (26.3% of all injuries to children involve the lower extremities and 32.4% for adults), it is the head, neck region that is most vulnerable to life-threatening injuries as seen in Table 4-37 (body region by pedestrian age for AIS severities 5 and 6); all AIS 5-6 injuries suffered by the pedestrian are included.

TABLE 4-37. - BODY REGION BY PEDESTRIAN AGE FOR ALL INJURIES RATED AIS 5,6 - ALL IMPACTS

	Pedestrian Age		
Body Area	≤ 10	> 10	Total
Head, Neck	37 (74.0)	133 (51.4)	170 (55.0)
Face	--	--	--
Chest	4 (8.0)	63 (24.3)	67 (21.7)
Abdomen	9 (18.0)	63 (24.3)	72 (23.3)
Pelvic-Hip	-	-	-
Upper Extremities	-	-	-
Lower Extremities	-	-	-
Whole Body	-	-	-
TOTAL	50 (100.0)	259 (100.0)	309 (100.0)

As evidenced in Table 4-37, the chest and abdomen are the only other areas to sustain AIS 5 or 6 injuries. The AIS 5-6 injuries to these two body areas comprise 5.5 percent and 4.3 percent respectively, of all injuries to children and 7.6 percent and 5.9 percent respectively, for adults (refer to Tables 4-31 and 4-32). Head and neck injuries comprise approximately one-sixth of all injuries to pedestrians and over half of the AIS 5-6 injuries. The remainder of this section will examine all head, neck injuries as well as critical to fatal head, neck injuries, comparing children with adults.

TABLE 4-38. - ALL HEAD, NECK INJURIES BY PEDESTRIAN AGE, SOURCE AND TYPE OF LESION

Pedestrian Age ≤ 10*

% of All Injuries to Head, Neck	Source	% of Injuries By Source	Lesion
58.4	Pavement	31.9	Contusion
		31.9	Concussion
		14.8	Abrasion
		12.5	Laceration
11.9	Hood Top	46.2	Contusion
		26.9	Concussion
		7.7	Abrasion
		7.7	Laceration
6.6	Front Fender	31.0	Concussion
		27.6	Contusion
		17.2	Laceration
5.9	Energy Transfer	57.7	Pain
		19.2	Fracture
		11.0	Other
		7.7	Dislocation

Pedestrian Age > 10**

% of All Injuries to Head, Neck	Source	% of Injuries By Source	Lesion
47.4	Pavement	29.3	Concussion
		27.9	Contusion
		20.6	Laceration
		12.2	Abrasion
14.5	Windshield/Trim	31.9	Laceration
		23.9	Contusion
		21.3	Concussion
14.0	Energy Transfer	61.5	Pain
		11.0	Other
		10.1	Fracture
11.4	Hood Top	30.3	Concussion
		27.0	Contusion
		16.9	Laceration
		12.4	Fracture
		6.7	Abrasion

*Head, neck injury = 16.5 percent of all injuries to children

**Head, neck injury = 16.3 percent of all injuries to adults

In Table 4-38, all head, neck injuries to pedestrians are summarized for perspective purposes. Data show that the hood top, the front fender area and "energy transfer" are the most frequent vehicle-related sources of injury to a child's head or neck. As evidenced in Table 4-31, no head, neck injury for a child resulted from contact with the windshield glass or trim. Injury sources for the head, neck region in adults, aside from pavement contacts, were the windshield area (6.7% glass, 7.8% glass and trim), "energy transfer" and the hood top.

For children, the primary lesions associated with the pavement, hood and top, and front fender contacts are concussion, contusion, abrasion and laceration. "Energy transfer" led to complaint of pain, fractures and dislocation, in children. For adults, concussion generally occurred from contact with the pavement or hood top, followed in succession by contusion, laceration and abrasion. Windshield glass or windshield glass and trim contacts primarily resulted in laceration, contusion and concussion. Energy transfer generally resulted in complaint of pain and bone fracture mostly occurred from energy transfer and hood top contact.

For additional perspective, the distribution of AIS ratings is provided in Table 4-39. AIS ratings for head, neck injuries to adults and children are concentrated in the 1-3 range; however, there are more pedestrians 10 or younger in the 1-3 category and more adults in the 5,6 class.

TABLE 4-39. - DISTRIBUTION OF AIS BY PEDESTRIAN AGE FOR ALL HEAD AND NECK INJURIES

	Pedestrian Age					
AIS	≤ 10		> 10		Total	
1-3	421	(87.5)	684	(79.4)	1,105	(82.3)
4	23	(4.8)	45	(5.2)	68	(5.1)
5,6	37	(7.7)	133	(15.4)	170	(12.7)
7-9	19	(---)	15	(---)	34	(---)
TOTAL	500	(100.0)	877	(100.0)	1,377	(100.0)

From Table 4-39, it appears that adults have a greater susceptibility to head and neck injuries with an AIS of 5 or 6. A total of 15.4 percent of adult head and neck injuries rated an AIS of 5 or 6, as compared to 7.7 percent for children. Two important variables that may affect this difference are examined below: source of injuries and impact speed. Impact type is limited to frontals because this impact type occurred most frequently in the study.

Table 4-40 presents the known injury sources for child and adult pedestrians for head and neck injuries rated AIS 5 or 6 in frontal impacts. Children suffer 50 percent of their known critical to fatal head, neck injuries from "energy transfer" and pavement contact. Critical to fatal injuries from energy transfer are usually neck fractures or dislocations resulting from a direct contact to another body area. The single most frequent source of injury is the pavement, which causes concussion, laceration and contusion (Table 4-38). Hood face and hood top related injuries represent 25 percent of the injuries to this body area, two-thirds of which were concussions (Table 4-41).

AIS ratings of 5 or 6 to an adult's head, neck area most frequently (26.2%, Table 4-40), resulted from pavement contact which causes concussions, contusions and lacerations (Table 4-41, 4-42). However, two vehicle areas combined exceed the pavement: the hood top (19.4%) and the windshield and trim (16.5%). Hood top injuries are nearly twice as frequent among adults as among children. Hood face injury of any severity to the head, neck area of an adult was rare. Energy transfer resulting in laceration, fracture, and dislocation also ranked high (Table 4-42).

TABLE 4-40. - SOURCE OF ALL AIS 5 OR 6 INJURIES TO HEAD, NECK AREA - FRONTAL IMPACTS

Source	Pedestrian Age ≤ 10		Pedestrian Age > 10		Total	
Grille, Headlights	1	(3.6)	0		1	(0.8)
Hood Face	4	(14.3)	0		4	(3.1)
Hood Top	3	(10.7)	20	(19.4)	23	(17.6)
Cowl, Wiper Blade Mount	0		2	(1.9)	2	(1.5)
Front Fender	3	(10.7)	13	(12.6)	16	(12.2)
Windshield Glass and Trim	0		17	(16.5)	17	(13.0)
Roof	0		1	(1.0)	1	(0.8)
Tires, Wheels	2	(7.1)	1	(1.0)	3	(2.3)
Undercarriage	1	(3.6)	2	(1.9)	3	(2.3)
Energy Transfer	6	(21.4)	19	(18.4)	25	(19.1)
Accessories, Ornaments	0		1	(1.0)	1	(0.8)
Pavement	8	(28.6)	27	(26.2)	35	(26.7)
Unknown	6	(---)	20	(---)	26	(---)
TOTAL	34	(100.0)	123	(100.0)	157	(100.0)

TABLE 4-41. - LESION BY SOURCE - ALL AIS 5 OR 6 HEAD OR NECK INJURIES - FRONTAL IMPACTS
PEDESTRIAN AGE ≤10

	Contusion	Dislo- cation	Frac- ture	Hemor- rhage	Con- cussion	Lacer- ation	Amputa- tion	Crushing	Other	Total
Grille, Headlights	1 (100.0)	0	0	0	0	0	0	0	0	1 (2.9)
Hood Face	0	0	0	0	3 (75.0)	0	0	1 (25.0)	0	4 (11.8)
Hood Top	1 (33.3)	0	0	0	2 (66.7)	0	0	0	0	3 (8.8)
Cowl, Wiper Blade Mount	0	0	0	0	0	0	0	0	0	0
Front Fender	0	1 (33.3)	1 (33.3)		0	1 (33.3)	0	0	0	3 (8.8)
Windshield Glass and Trim	0	0	0	0	0	0	0	0	0	0
Roof	0	0	0	0	0	0	0	0	0	0
Tires, Wheels	0	0	0	0	0	2 (100.0)	0	0	0	2 (5.9)
Undercarriage	0	0	0	0	1 (100.0)	0	0	0	0	1 (2.9)
Energy Transfer	0	2 (33.3)	3 (50.0)	0	0	1 (16.7)	0	0	0	6 (17.6)
Accessories, Ornaments	0	0	0	0	0	0	0	0	0	0
Pavement	2 (25.0)	1 (12.5)	0	0	3 (37.5)	2 (25.0)	0	0	0	8 (23.5)
Unknown	1 (16.7)	1 (16.7)	1 (16.7)	0	3 (50.0)	0	0	0	0	6 (17.6)
TOTAL	5 (14.7)	5 (14.7)	5 (14.7)	0	12 (35.3)	6 (17.7)	0	1 (2.9)	0	34 (100.0)

TABLE 4-42. - LESION BY SOURCE - ALL AIS 5 OR 6 HEAD OR NECK INJURIES - FRONTAL IMPACTS

PEDESTRIAN AGE > 10

	Contusion	Dislocation	Fracture	Hemorrhage	Concussion	Laceration	Amputation	Crushing	Other	Total
Grille, Headlights	0	0	0	0	0	0	0	0	0	0
Hood Face	0	0	0	0	0	0	0	0	0	0
Hood Top	6 (30.0)	1 (5.0)	2 (10.0)	3 (15.0)	2 (10.0)	6 (30.0)	0	0	0	20 (16.3)
Cowl, Wiper Blade Mount	1 (50.0)	0	0	0	1 (50.0)	0	0	0	0	2 (1.6)
Front Fender	5 (38.5)	1 (7.7)	1 (7.7)	1 (7.7)	2 (15.4)	3 (23.1)	0	0	0	13 (10.6)
Windshield Glass and Trim	4 (23.5)	0	2 (11.8)	2 (11.8)	4 (23.5)	4 (23.5)	1 (5.9)	0	0	17 (13.8)
Roof	0	0	0	0	1 (100.0)	0	0	0	0	1 (0.8)
Tires, Wheels	0	0	0	0	0	0	0	1 (100.0)	0	1 (0.8)
Undercarriage	0	0	0	0	0	1 (50.0)	0	1 (50.0)	0	2 (1.6)
Energy Transfer	0	5 (26.3)	6 (31.6)	0	0	8 (42.1)	0	0	0	19 (15.5)
Accessories, Ornaments	0	0	0	0	0	1 (100.0)	0	0	0	1 (0.8)
Pavement	8 (29.6)	1 (3.7)	2 (7.4)	3 (11.1)	7 (25.9)	4 (14.8)	0	1 (3.7)	1 (3.7)	27 (22.0)
Unknown	2 (10.0)	1 (5.0)	3 (15.0)	3 (15.0)	4 (20.0)	7 (35.0)	0	0	0	20 (16.3)
TOTAL	26 (21.1)	9 (7.3)	16 (13.0)	12 (9.8)	21 (17.1)	34 (27.6)	1 (0.8)	3 (2.4)	1 (0.8)	123 (100.0)

Only calculated impact speeds are used in Table 4-43. In accidents where the pedestrian suffers an AIS 5-6 head or neck injury, children have a higher percentage of these accidents in the speed range below 30 MPH. Of the known speeds, 11 of 15 (or 73.3%) of child pedestrian accidents of this type occur in the 16-30 MPH impact speed range. A total of 40.0 percent (10/25) of adult pedestrian accidents occur in the 16-30 MPH speed range. Children's accidents, where impact speeds are known, are concentrated in the 16-30 MPH range with only a small proportion of accidents above 30 MPH. Adults, however, experience slightly more than half of their AIS 5-6 accidents at speeds above 30 MPH.

TABLE 4-43. - IMPACT SPEED BY PEDESTRIAN AGE - FRONTAL IMPACTS
ALL HEAD OR NECK INJURIES: AIS 5 OR 6

Impact Speed	Pedestrian Age ≤ 10		Pedestrian Age >10		Total	
0-5	0		0		0	
6-10	0		1	(4.0)	1	(2.5)
11-15	2	(13.3)	1	(4.0)	3	(7.5)
16-30	11	(73.3)	10	(40.0)	21	(52.5)
31 and Above	2	(13.3)	13	(52.0)	15	(37.5)
Unknown	0	(---)	0	(---)	0	(---)
TOTAL	15	(37.5)	25	(62.5)	40	(100.0)

It appears, therefore, that impact speed is a contributing factor in the apparently greater susceptibility of adults to AIS 5-6 head or neck injuries.

Another important consideration in examining critical and fatal injury is the differences in vehicle-pedestrian interaction that occur for adults and children (Table 4-44).

TABLE 4-44. - ALL INJURIES TO HEAD AND NECK (AIS 5 OR 6) - VEHICLE-PEDESTRIAN INTERACTION BY PEDESTRIAN AGE - FRONTAL IMPACTS

Vehicle-Pedestrian Interaction	Pedestrian Age ≤10		Pedestrian Age >10		Total	
Carried by Vehicle	1	(3.9)	22	(28.2)	23	(22.1)
Rotated Over Vehicle Top	0		12	(15.4)	12	(11.5)
Thrown Forward	21	(80.8)	34	(43.6)	55	(52.9)
Knocked to Pavement	3	(11.5)	7	(9.0)	10	(9.6)
Shunted to Left/Right	0		1	(1.3)	1	(1.0)
Other	1	(3.9)	2	(2.6)	3	(2.9)
Unknown	0	(---)	7	(---)	7	(---)
TOTAL	26	(100.0)	85	(100.0)	111	(100.0)

Adult pedestrians are more likely to be carried by the vehicle or rotated over the vehicle top than children who, instead, are more likely to be thrown forward or knocked to the pavement. Examination of the average impact speed for each vehicle-pedestrian interaction would be helpful to determine if this combination affects injuries of this nature. The impact speeds are divided into three categories: I: calculated speeds only; II: calculated speeds plus speeds from witnesses and those determined from the pedestrian's throw distance, and finally III: all of the above plus speeds determined from an injury-speed curve. (The latter category cannot be used to detect relationships between pedestrian injury and impact speed, but may be used to determine whether there are speed differences between the accident types.) (See Table 4-45.)

TABLE 4-45. - VEHICLE-PEDESTRIAN INTERACTION BY AVERAGE IMPACT SPEED - FRONTAL IMPACTS

ALL HEAD OR NECK INJURIES (AIS 5 OR 6)

Vehicle-Pedestrian Interaction	Data Source for Impact Speeds I			II			III		
	$\bar{X}$	N	σ_m	$\bar{X}$	N	σ_m	$\bar{X}$	N	σ_m
Carried by Vehicle	36.9	8	5.9	35.4	13	4.1	31.1	23	2.7
Rotated Over Vehicle Top	49.0	4	7.3	42.2	11	3.0	41.1	12	3.0
Thrown Forward	25.8	24	1.9	28.4	39	2.0	27.7	55	1.5
Knocked to Pavement	13.0	2	7.0	20.8	8	5.2	19.1	9	4.8
Shunted to Left/ Right	-	-	-	30.0	1	-	30.0	1	-

Accidents involving head or neck injuries with an AIS of 5 or 6 in which the pedestrians are carried by the vehicle or rotated over the vehicle top, appear to be associated with higher impact speeds than cases where the pedestrian is thrown forward or knocked to the pavement. This is consistent with previous findings in this section that adults are more likely than children to be carried by the vehicle or rotated over its top. Also, adult pedestrian accidents of this type tend to occur at higher impact speeds than the same class of accidents for children.

An interesting point to note from examining the sources for head or neck injury and also vehicle-pedestrian interaction is that even for a pedestrian who is carried by the vehicle and sustains critical or fatal head/ neck injuries from vehicle components, the pavement represents a significant proportion of head or neck injuries within the "carried by vehicle" class. Conversely, pedestrians thrown forward or knocked to the pavement, receive a large proportion of their injuries from vehicle components as well as the pavement.

4.10 Fatal and Non-Fatal Pedestrian Accidents, Frontal Impacts

Frontal impacts of a vehicle with a pedestrian are, as stated earlier, not only the most frequent, but also the most severe, pedestrian accidents. One reason for this is that the speeds generally are higher than those in rear impacts and because the impact is more often a direct one than in side impacts which frequently result in a glancing blow to the pedestrian. A number of other variables which are associated with fatal frontal impacts with a pedestrian are discussed in this section.

The data in Table 4-46 indicate that as vehicle size increases, the proportion of fatalities also increases. The major exception is the category "luxury vehicle or limousine" which has the lowest proportion of fatals. The reason for this is not clear, but it may be a function of the small sample size or it may possibly be related to the type and location of driving rather than the vehicle type. Weighted data are used in this table because of differences in fatal and non-fatal sampling.

TABLE 4-46. - FATAL ACCIDENTS BY VEHICLE TYPE*

Vehicle Type	Fatal		Non-Fatal		Total Vehicles	Percent Fatal
	N	%	N	%		
Minicar	27	12.8	689	19.6	716	3.8
Compact	44	20.9	703	20.0	747	5.9
Intermediate	37	17.5	817	23.2	854	4.3
Full Size	43	20.4	685	19.5	728	5.9
Luxury/Limousine	9	4.3	172	4.9	181	5.0
Small Van	11	5.2	92	2.6	103	10.7
Pickup	31	14.7	233	6.6	264	11.7
Other/Unknown	9	4.3	125	3.6	134	6.7
TOTAL	211	100.0	3,516	100.0	3,727	5.7

*Weighted data used in this table.

Impact speed data are provided in Table 4-47 for both fatal and non-fatal accidents. Impact speeds shown are calculated speeds.

TABLE 4-47. - COMPUTED IMPACT SPEEDS IN FATAL AND NON-FATAL FRONTAL PEDESTRIAN ACCIDENTS*

Computed Speed (MPH)	Fatal #	Fatal %	Non-Fatal #	Non-Fatal %	Percent Surviving
0-5 MPH	0	0	97	26.5	100.0
6-10	0	0	175	39.3	100.0
11-15	6	9.2	92	19.9	97.2
16-20	7	10.7	35	7.2	91.4
21-25	8	13.0	22	4.3	84.9
26-30	15	35.1	8	1.2	34.3
30 MPH or higher	22	32.1	7	1.6	44.7
Total	58	100.0	436	100.0	94.0
Not Computed	118		857		
Total Accidents	176		1,293		

*Weighted data used in this table.

As one would expect, the impact speeds are higher for fatal accidents than for non-fatal accidents: all of the fatal accidents occurred at computed speeds of 11 MPH or higher compared with 34.2 percent for the non-fatal accidents. This does not mean that some fatal accidents did not occur at lower speeds. A few did, but speeds could only be estimated because of the lack of physical evidence discussed earlier. At computed impact speeds up to 10 MPH, all pedestrians survived. Above that speed, the proportion of survivors declined rapidly up to 30 MPH. Above that speed, less than about 45 percent survived, most at speeds close to 30 MPH.

Please note that throughout this section, the numbers of vehicles and pedestrians in fatal accidents is 176 and in non-fatal accidents it is 1,293. To simplify data analysis, only the first pedestrian contacted is included in these data. This resulted in deletion of 53 pedestrians.

The 176 fatally injured pedestrians involved in frontal impacts sustained 1,522 separate injuries (Table 4-48) which were rated using the Abbreviated Injury Scale (AIS). There were 272 ratings of AIS 5 or 6 (life threatening or fatal injuries) or approximately 1.5 such ratings per person. All of these involved the head, neck, chest or abdomen area. There were a similar number of AIS 4 ratings (268). For the AIS 4 ratings, the same body areas were involved as for the AIS 5, 6 injuries, with the addition of the lower extremities. Other areas were involved to a lesser degree. The head, chest, abdomen and lower extremities all suffered multiple lesions for the fatally injured (176 pedestrians, over 200 injuries per area). It is important to note that the extremities cannot be assigned a 5 or 6 rating in the AIS system because death, even with severe injury, is rare.

The 1,293 non-fatally injured pedestrians sustained 5,172 separate injuries or an average of 4 per person (Table 4-49). This compares with the average of 8.6 injuries per fatally injured pedestrian. In contrast with the fatalities only 18 AIS 5 injuries (.35%) were sustained while 4,279, or 82.7 percent, sustained AIS 1 injuries. Also, only 1.9 percent of the injuries to non-fatally injured pedestrians were life-threatening injuries, i.e., an injury above AIS 3. This compares with 35.5 percent for fatally injured pedestrians. The body areas most frequently injured differed as well: among the non-fatally injured, the lower extremities, upper extremities, head, neck and face ranked highest; among those fatally injured, the head, neck, chest, lower extremities and abdomen ranked highest. It is clear that the fatally injured pedestrian is injured more extensively, more severely and to more vulnerable body areas than the non-fatally injured pedestrian.

The most frequent sources of injury in non-fatal frontal accidents are provided in Table 4-50. All injuries caused by a source are recorded so the total may exceed 100 percent. The leading sources were identical for automobiles of all sizes: pavement, bumper face, hood top and hood face

TABLE 4-48 . - DISTRIBUTION OF AIS BY BODY AREA FOR ALL INJURIES IN FATAL FRONTAL IMPACTS

Body Area	AIS 1		2		3		4		5		6		8		TOTAL	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
Head, Neck	54	17.31	39	12.50	25	8.01	46	14.74	93	29.81	52	16.67	3	0.96	312	100.00
Face	110	75.86	22	15.17	10	6.90	3	2.07	0	0.00	0	0.00	0	0.00	145	100.00
Chest	30	10.49	21	7.34	114	39.86	57	19.93	56	19.58	8	2.80	0	0.00	286	100.00
Abdomen	21	8.71	2	0.83	65	26.97	89	36.93	58	24.07	5	2.07	1	0.41	241	99.99
Pelvic-Hip	21	18.42	38	33.33	50	43.86	5	4.39	0	0.00	0	0.00	0	0.00	114	100.00
Upper Extrem.	102	61.08	37	22.16	25	14.97	3	1.80	0	0.00	0	0.00	0	0.00	167	100.01
Lower Extrem.	98	38.28	59	23.05	34	13.28	65	25.39	0	0.00	0	0.00	0	0.00	256	100.00
Whole Body	1	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	100.00
TOTAL	437	28.71	218	14.32	323	21.22	268	17.61	207	13.60	65	4.27	4	0.26	1,522	100.00

TABLE 4-49. - DISTRIBUTION OF AIS BY BODY AREA FOR ALL INJURIES IN NON-FATAL FRONTAL IMPACTS

Body Area	AIS 1 N	AIS 1 %	AIS 2 N	AIS 2 %	AIS 3 N	AIS 3 %	AIS 4 N	AIS 4 %	AIS 5 N	AIS 5 %	AIS 8 N	AIS 8 %	TOTAL N	TOTAL %
Head, Neck	622	73.87	151	17.93	16	1.90	15	1.78	12	1.43	25	2.97	841	100.00
Face	760	93.83	40	4.94	10	1.23	0	0.00	0	0.00	0	0.00	810	100.00
Chest	158	74.53	15	7.08	35	16.51	3	1.42	0	0.00	1	0.47	212	100.01
Abdomen	97	59.15	2	1.22	40	24.39	16	9.76	6	3.66	3	1.83	164	100.01
Pelvic-Hip	360	81.26	39	8.80	44	9.93	0	0.00	0	0.00	0	0.00	443	99.99
Upper Extrem.	900	88.24	74	7.25	43	4.22	2	0.20	0	0.00	1	0.10	1,020	100.01
Lower Extrem.	1,378	82.12	143	8.52	109	6.50	46	2.74	0	0.00	2	0.12	1,678	100.00
Whole Body	4	100.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0,00	4	100.00
TOTAL	4,279	82.72	464	8.97	297	5.74	82	1.59	18	0.35	32	0.62	5,172	100.00

TABLE 4-50. - MAJOR SOURCES OF INJURY BY VEHICLE TYPE IN FRONTAL IMPACTS
(Injury Rate for Non-Fatally Injured Pedestrians - All Injuries/NF Pedestrians)

	Injury Source							
Vehicle Type		Rate		Rate		Rate		Rate
Minicar	Pavement	.83	Bumper face	.35	Hood top	.31	Hood face	.19
Compact	Pavement	.97	Bumper face	.35	Hood top	.23	Hood face	.19
Intermediate	Pavement	.92	Bumper face	.36	Hood top	.25	Hood face	.11
Full-Size	Pavement	.96	Bumper face	.39	Hood top	.22	Hood face	.19
Luxury/Limousine	Pavement	.98	Bumper face	.35	Hood top	.28	Hood face	.23
Small Van	Pavement	1.05	Bumper face	.14	Hood face	.14	Grille	.14
Pickup	Pavement	1.16	Bumper face	.30	Hood face	.28	Grille	.12

(Table 4-50). For small vans and pickups, the leading sources of injury were the pavement, bumper face, hood face and grille. Thus, pedestrians frequently contacted the hood top of cars but not of light trucks (some vans, of course, had no hood top). Injuries caused by the pavement were somewhat more frequent for van and pickup impacts than for cars. Minicar accidents resulted in pavement injuries least often.

In fatal accidents, the pavement was the most frequent source of injury when vehicles larger than a compact were involved (Table 4-51). Among compacts and minicars, the hood top instead of the pavement was the leading injury source. The hood top also ranked second for all other automobiles.

There is a distinct pattern change in comparing non-fatal to fatal accidents. For minicars and compacts, the hood top shifts from third to the leading source of injury in fatal accidents. The hood top also shifts to second position in fatal accidents (from third in non-fatal accidents) for intermediate, full size and luxury/limousine cars. In fatal accidents, the proportion of injuries associated with the individual vehicle components is much larger than in non-fatal accidents, often by a factor of two or three. On the other hand, the pavement as an injury source declines in fatal accidents.

The source of the severest pedestrian injury (highest AIS) in non-fatal frontal impacts is remarkably similar for most vehicle types (Table 4-52). The pavement, front bumper face, hood face and hood top rank highest and generally in that order for most vehicles. For small vans and pickups, the contacts are generally on the front area of the vehicle, and hood top drops below the first four sources. Although the pavement ranks as first for all but minicars, the proportion of pedestrians for whom this is the source of severest injury is highest for vans, followed by pickups.

TABEL 4-51. - MAJOR SOURCES OF INJURY BY VEHICLE TYPE IN FRONTAL IMPACTS
(Injury Rate for Fatally Injured Pedestrians - All Injuries/Fatal Pedestrians)

Vehicle Type	Injury Source	Rate	Injury Source	Rate	Injury Source	Rate	Injury Source	Rate
Minicar	Hood top	.74	Bumper face	.65	Pavement	.57	Hood face	.52
Compact	Hood top	.88	Pavement	.75	Bumper face	.69	Hood face	.50
Intermediate	Pavement	.80	Hood top	.77	Bumper face	.49	Trim (headlight)	.37
Full-Size	Pavement	.88	Hood top	.60	Tires (40% each)	.38	Bumper face	.33
Luxury/Limousine	Pavement	1.20	Trim (grille)		Bumper guard		Trim (headlight) Hood top	
Small Van	Pavement	.86	Bumper face	.71	Trim (headlight)		Hood face	.57
Pickup	Pavement	1.04	Hood face	.65	Bumper face	.39	Hood top	.30

TABLE 4-52. - SOURCE OF HIGHEST AIS BY VEHICLE TYPE
(NON-FATAL ACCIDENTS)

Vehicle Type	Injury Source	%		%		%		%
Minicar	Bumper Face	26.3	Pavement	25.9	Hood Face	7.8	Hood Top	6.9
Compact	Pavement	31.8	Bumper Face	20.1	Hood Face	9.2	Hood Top	7.1
Intermediate	Pavement	27.9	Bumper Face	21.6	Hood Top	10.2	Hood Face	4.6
Full-Size	Pavement	32.4	Bumper Face	20.5	Hood Face	9.0	Hood Top	6.1
Luxury/Limousine	Pavement	25.4	Bumper Face	25.4	Hood Face	13.6	Bumper Guard	11.9
Small Van	Pavement	50.0	Hood Face	11.1	Std. Tire	11.1	Headlt. Trim	5.6
Pickup	Pavement	34.1	Bumper Face	12.5	Hood Face	11.4	Grille	4.5

The source of the injury with the highest AIS in fatal pedestrian accidents is dramatically different than that for non-fatal accidents (Table 4-53). The pavement does not even appear for two vehicle types and except for pickups, drops to third or lower when it does appear. The hood top and energy transfer dominate the first two positions for all cars and such sources as tires, fender, undercarriage and windshield area also appear. It is evident that, for minicars, the pedestrian contacts the hood top from the hood face rearward to the windshield and frame. The general picture emerging is one of higher speeds and greater forces with the role of the vehicle being far more prominent than in non-fatal accidents.

TABLE 4-53. - SOURCE OF HIGHEST AIS BY VEHICLE TYPE (FATAL FRONTAL ACCIDENTS)

	Injury Source									
Vehicle Type		%		%		%		%		%
Minicar	Hood Top	17.4	Bumper Face	8.7	Wind-shield Glass	8.7	Wind-shield gl. & Trim (Top)	8.7	Wind-shield gl. & Trim (Bottom)	8.7
Compact	Energy Trans.	23.5	Hood Top	14.7	Pavement	8.8	Front Bumper Face	5.9	St. Tire	5.9
Intermediate	Hood Top	21.2	Energy Trans	15.2	Pavement	6.1	Front Fender	6.1	Wind-shield gl. & A-pillar	6.1
Full Size	Energy Trans.	12.8	Hood Top	10.3	Std. Tire	10.3	Pavement	10.3		
Lux./Limo	Energy Trans.	40.0	Headlight Trim	20.0	Front Fender	20.0	Under-carriage	20.0		
Small Van	Hood Face	28.5	Front Bumper	14.3	Fender Edge	14.3	Energy Trans.	14.3	Pavement	14.3
Pickup	Pavement	26.1	Hood Face	21.7	Energy Trans.	13.1	Front Bumper Face	4.3	Grille Edge	4.3

4.11 Injury Source, Severity and Type in Side Impacts

The majority of pedestrian accidents involve frontal impacts; however, just over 20 percent of the accidents consisted of side impacts. These accidents are briefly reviewed in this section. Table 4-54, the distribution of the highest AIS injury severity is presented for both side and frontal impacts. The side pedestrian impacts are far less severe than frontal impacts and the difference is statistically significant ($X^2 = 1103.45$, $\phi' = 0.85$).

TABLE 4-54. - DISTRIBUTION OF THE HIGHEST AIS IN FRONTAL AND SIDE IMPACTS

AIS Injury Severity	Side N	Side %	Frontals N	Frontals %
0	8	1.8	12	0.8
1	308	68.4	795	55.5
2	80	17.8	212	14.8
3	28	6.2	168	11.7
4	20	4.4	88	6.1
5	4	0.9	102	7.1
6	2	0.4	55	3.8
8	30	-	93	-
9	2	-	1	-
TOTAL	482	100.0	1,526	100.0

It is notable in Table 4-54 that there were only two side impact accidents in which the pedestrian sustained an injury of severity level 6. Also, the frequency of AIS 3, 4 and 5 injuries is much lower than in frontal impacts and AIS 1 and 2 injuries are, correspondingly, more frequent.

It is not surprising, then, that there are fewer head and neck involvements which generally resulted in the most severe lesion suffered by a pedestrian. Table 4-55 provides the frequency with which each body area sustained the highest rated AIS; for convenience, the corresponding distribution for frontal impacts is also shown. It is evident that the lower proportion of head/neck involvements is offset by a higher proportion of upper and lower extremity injuries in side impacts.

TABLE 4-55. - BODY AREA WITH THE HIGHEST AIS - FRONTAL AND SIDE IMPACTS

	Side Impacts		Frontal Impacts	
Body Area	N	%	N	%
Head/Skull/Neck/Face	125	28.7	522	36.0
Upper Extremities	81	18.6	162	11.2
Chest	8	1.8	54	3.7
Abdomen	6	1.4	77	5.3
Back	12	2.8	40	2.8
Pelvis/Hip	15	3.4	109	7.5
Lower Extremities	189	43.3	488	33.6
Unknown	1	---	4	---
TOTAL	437	100.0	1,456	100.0

The sources of pedestrian injuries with the highest AIS are given in Table 4-56. Obviously, this cannot be compared directly to frontal impact injury sources. However, almost a third of these injuries can be attributed to contacts with the pavement. A similar proportion of frontal impact accidents involved pavement contacts which resulted in the highest AIS.

TABLE 4-56. - SOURCE OF HIGHEST AIS IN SIDE IMPACT PEDESTRIAN ACCIDENTS

Injury Source	N	%
Front Bumper Face	9	2.2
Hood	5	1.2
Front Fender	58	14.5
Windshield and Trim	15	3.7
Roof, Roof Pillars and Side Rail	14	3.5
Door and Lower Side Area	28	7.0
Rear Fender/Trunk Lid	25	6.2
Rear Bumper Face	5	1.2
Tires and Wheels	55	13.7
Undercarriage	1	0.2
Energy Transfer	18	4.5
Accessories and Ornamentation	36	9.0
Other Vehicle	2	0.5
Pavement	128	31.9
Other	2	0.5
Unknown	36	---
TOTAL	437	100.0

There were fourteen cases in which the pedestrian was struck by the bumper face (nine front, five rear). This situation is indicative of a wrap-around type bumper rather than a coding error, as may be suspected initially. Note also that there were no cases in which the severest injury resulted from contact with one of the vehicle's side windows. Also of interest is the fact that 32 of the 36 contacts with an ornament or accessory involved side rear view mirrors. A majority of these injuries were minor (AIS 1).

The interaction between the vehicle and pedestrian was also investigated and is presented in Table 4-57, categorized by injury severity level. It is noteworthy that the most common result of a side pedestrian impact is that the pedestrian is knocked to the pavement; this occurs in over 70 percent of the cases. Clinical analysis of the data indicates that the majority of pedestrians (categories 1 and 2) walk into the side of the vehicle and generally are sideswiped or rotated away, falling to the pavement. Serious injuries occur when the upper part of the body moves in front of the A pillar, windshield area as a pedestrian wraps over the fender and hood. The head and torso then are struck by these components. A car skidding laterally also produces serious injuries as it bears down upon the pedestrian rather than sideswiping him.

TABLE 4-57. - SIDE IMPACT VEHICLE-PEDESTRIAN INTERACTION BY AIS SEVERITY

Vehicle-Pedestrian Interaction	AIS Severity 0	1	2	3	4	5	6	8	9	Total	
Knocked to Pavement	8	214	61	19	13	3	2	18	0	338	(72.4)*
Bumped/Pushed Aside	0	34	6	1	0	0	0	6	0	47	(10.1)
Snagged; Rotated	0	15	5	3	1	0	0	0	0	24	(5.1)
Snagged; Dragged by Vehicle	0	1	1	0	1	0	0	0	0	3	(0.6)
Feet/Legs Run Over	0	30	6	4	5	0	0	1	0	46	(9.9)
Other	0	6	0	1	0	1	0	1	0	9	(1.9)
Unknown	0	8	1	0	0	0	0	4	2	15	(---)
TOTAL	8	308	80	28	20	4	2	30	2	482	(100.0)

*Percent of grand total (less unknowns) in parentheses.

There is little difference in the injury levels for the different interactions and the vast majority of injuries were relatively minor: 81 percent were AIS 1 or 2. Consequently, the vehicle-pedestrian interaction does not appear to be a primary factor in pedestrian side impact injuries.

Impact speed was next examined to determine its contribution to pedestrian injury. Average impact speeds were computed for each AIS level, and are presented in Table 4-58. There is a trend in the data, which suggests that increased impact speed causes greater injury. The volume of data, unfortunately, is not large enough to allow this to be demonstrated statistically. There are, for example, only fifteen cases with AIS severity ratings of 3 or greater. Clinical analysis of side impacts indicated that none of the pedestrians died as a result of a vehicle sideswipe; only when they were in front of a laterally skidding vehicle, or when the upper body and head moved in front of the A-pillar/windshield area did serious injury occur.

TABLE 4-58. - MEAN CALCULATED IMPACT SPEED BY INJURY LEVEL (SIDE IMPACTS)

Overall AIS Severity	N	Mean (MPH)	σ_m
1	63	12.3	1.2
2	17	17.0	2.6
3	7	15.4	3.1
4	4	23.8	6.6
5	3	29.7	4.7
6	1	21.0	--

5. COSTS ASSOCIATED WITH PEDESTRIAN ACCIDENTS

In discussing pedestrian accident costs, the most obvious method of quantification is the societal cost. Societal costs have been determined for each AIS severity rating (Reference 14) and are expressed in terms of 1975 dollars, the data available as this is written. Data were collected from August 1977 to March 1980 so the estimates would tend to be somewhat lower than they would be today. There are a number of components which have been used in the overall cost determination. All of these components are not applicable to pedestrian accidents. Specifically, it is not believed that the costs for vehicle damage or for losses to other parties are very large; in the original formulation it ranges from $315 to $4,990. They have therefore been excluded. The individual cost components are shown in Table 5-1 and are categorized by AIS level.

TABLE 5-1. - COST COMPONENTS FOR INJURIES OF EACH SEVERITY LEVEL (1975 DOLLARS)

	AIS Level						
Component	6	5	4	3	2	1	0
Production/Consumption	$275,365	$164,645	$72,210	$2,070	$995	$85	$0
Medical	565	17,345	7,450	1,620	615	100	0
Funeral	925	0	0	0	0	0	0
Legal	2,190	1,645	1,090	770	150	140	7
Insurance Administration	295	295	285	240	220	52	30
Accident Investigation	80	80	70	45	35	28	6
Traffic Delay	80	60	60	160	160	160	160
TOTAL	$279,500	$184,070	$81,165	$4,905	$2,175	$565	$203

By applying the costs given in Table 5-1 to the weighted number of accidents of each severity (see Table 3-37), the aggregate cost of pedestrian accidents over the data collection period can be estimated for the applicable areas. This results in a cost of $70,407,572 for a total of 5,089 pedestrian accidents, or an average of $15,109 per accident (based on the 4,660 accidents with known injury). Since there are at least 110,000 pedestrian accidents in the United States each year, the total cost to society of the pedestrian accident problem is, at a minimum, $1.7 billion dollars.

There are some problems, of course, with the previous cost figures. Notably, inflation has not affected all components equally. Secondly, the AIS categorizations have been changed so that a severity of 6 can only be given to a fatal, currently untreatable lesion. Previously, however, victims dying within thirty days of the accident were given a 6 rating. This explains why funeral costs are only associated with AIS 6 injuries. Furthermore, the inclusion of indirect costs, such as the Production/Consumption component, is open to debate. An injured person's place in society is filled by another individual, thus making an estimate of the actual differential cost to society is difficult indeed.

Nevertheless, the societal cost figure does provide some indication of the severity of the pedestrian accident problem. A second approach is to collect data on variables directly related to the disabling effect of the injury. Data elements such as the number of days hospitalized, the number of days the pedestrian was restricted to bed, or whether any long-term disabilities were sustained were contained in the Pedestrian Accident Data Base.

Since it was determined that adjusting the data for sampling affects the relative frequencies of severity related measures (see Section 3.4), the following analyses were performed using the weighted data.

In Table 5-2, the number of long-term disabilities suffered are listed for each AIS severity level. Note that the percentages do not include the fatalities or unknowns.

TABLE 5-2. - LONG TERM DISABILITY ASSOCIATED WITH EACH AIS SEVERITY LEVEL

AIS Severity	Long Term Disability: No		Yes		Fatal	Unknown	Total
0	50	(1.00)	0		0	4	54
1	2,255	(.98)	45	(.02)	2	833	3,135
2	372	(.97)	13	(.03)	3	303	691
3	138	(.80)	34	(.20)	21	293	486
4	46	(.64)	26	(.36)	32	140	244
5	0		4	(1.00)	117	32	153
6	0		0		60	0	60
8	45	(.94)	3	(.06)	5	361	414
9	4	(1.00)	0		0	12	16
TOTAL	2,910	(.96)	125	(.04)	240	1,978	5,253

*The percent of the row total, less fatalities and unknowns, appears in parentheses.

The results presented in Table 5-2 show, not surprisingly, that the probability of long-term disability incurred from pedestrian accidents increased with the severity of the victim's injury. Not included in these results is any assessment of the extent of the disability; certainly one cannot compare the debilitating effects of torn knee ligaments to those of quadrapiligia. No measure of the extent of disability was contained in the automated data file. The necessary information can be obtained, however, from the hard copy case report forms.

Several other variables thought to be directly related to the cost of the pedestrian accident are included in the Pedestrian Accident Data Base. Tables 5-3 through 5-6 present the respective distributions, broken down by overall AIS level for: the number of days hospitalized, the number of days confined to bed, the number of days the victim was restricted from normal activity, and the number of days which were missed from work. In each of these tables, the data are adjusted for sampling.

TABLE 5-3. - LENGTH OF STAY IN HOSPITAL BY INJURY SEVERITY

Time in Hospital	AIS Severity 0	1	2	3	4	5	6	8	9	Total
0 Days	49	2,551	254	92	17	0	0	228	15	3,206
1-10 Days	0	235	282	137	82	32	1	19	0	788
11-20 Days	0	52	35	78	22	5	0	4	0	196
3-6 Weeks	0	36	42	71	42	19	0	11	0	221
7-10 Weeks	0	15	6	15	19	3	0	1	0	59
11-20 Weeks	0	0	4	18	9	2	0	1	0	34
Fatal, Not Admitted	0	2	3	10	21	90	59	4	0	189
Not Applicable	5	5	0	0	0	0	0	0	0	10
Unknown	0	238	65	65	31	3	0	145	1	548
TOTAL	54	3,134	691	486	243	154	60	413	16	5,251

TABLE 5-4. - BED REST BY INJURY SEVERITY

Time Confined to Bed	AIS Severity 0	1	2	3	4	5	6	8	9	Total
0 Days	47	1,849	238	115	45	2	0	25	4	2,325
1-10 Days	0	394	160	53	30	7	0	9	0	653
11-20 Days	0	20	20	27	9	0	0	0	0	76
3-6 Weeks	0	66	22	32	14	8	0	1	0	143
7-10 Weeks	0	13	9	12	6	2	0	0	0	42
11-20 Weeks	0	15	4	7	0	0	0	0	0	26
More than 5 Months	0	1	0	5	0	0	0	0	0	6
Fatal	0	2	3	21	32	117	60	5	0	240
Not Applicable	5	8	0	0	0	0	0	0	0	13
Unknown	2	766	236	213	107	18	0	373	12	1,727
TOTAL	54	3,134	692	485	243	154	60	413	16	5,251

TABLE 5-5. - LENGTH OF ACTIVITY RESTRICTION BY INJURY SEVERITY

Restriction Duration	AIS Severity									
	0	1	2	3	4	5	6	8	9	Total
0 Days	47	2,114	253	103	31	10	0	28	4	2,590
1-10 Days	0	76	20	17	0	0	0	2	0	115
11-20 Days	0	43	13	16	4	0	0	0	0	76
3-6 Weeks	0	47	59	19	18	5	0	5	0	153
7-10 Weeks	0	20	7	25	14	1	0	2	0	69
11-20 Weeks	0	14	16	21	5	0	0	0	0	56
More than 5 Months	0	4	0	8	8	0	0	0	0	20
Fatal	0	2	3	21	32	117	60	5	0	240
Not Applicable	5	24	13	0	0	0	0	5	0	47
Unknown	2	790	307	256	132	20	0	365	12	1,884
TOTAL	54	3,134	691	486	244	153	60	412	16	5,250

TABLE 5-6. - WORK TIME LOST BY INJURY SEVERITY

Time Out of Work	AIS Severity									
	0	1	2	3	4	5	6	8	9	Total
0 Days	21	546	77	40	5	6	0	9	0	704
1-10 Days	0	212	42	19	0	0	0	3	0	276
11-20 Days	0	43	6	6	7	0	0	0	0	62
3-6 Weeks	0	38	14	2	8	5	0	0	0	67
7-10 Weeks	0	23	6	3	0	0	0	0	0	32
11-20 Weeks	0	33	3	12	0	0	0	0	0	48
More than 5 Months	0	1	5	0	3	0	0	0	0	9
Fatal	0	2	3	21	32	117	60	5	0	240
Not Applicable	31	1,762	431	262	131	15	0	188	4	2,824
Unknown	3	473	104	120	59	10	0	208	12	989
TOTAL	55	3,133	691	485	245	153	60	413	16	5,251

In the tables just presented, it can be seen that the involved pedestrians are frequently disabled for a relatively long period of time. This obviously will be a significant cost factor in pedestrian injuries. It is felt, however, that the extent of permanent disability may be a more important aspect to the overall cost figure, particularly in view of the large proportion of children and young adults typically involved in pedestrian accidents.

It should be noted that in Table 5-6, pedestrians who were not employed at the time of the accident were coded "Not Applicable" for work time lost. Since about half the pedestrians were children under 15 years old, the large number of "Not Applicables" is understandable.

It is known that the NHTSA is interested in pedestrian protection, at speeds up to 30 MPH. Within this context, aggregate distributions for each of the data elements discussed in this section (except long term disability) are presented in Tables 5-7 and 5-8. Table 5-7 uses cases for which the impact speed was calculated to be less than 30 MPH from scene evidence; Table 5-8 uses speed estimates from all sources. Similarly, Tables 5-9 presents the long-term disability frequencies for pedestrian accidents under 30 MPH.

TABLE 5-7. - COST SOURCE DISTRIBUTIONS - 30 MPH OR LOWER IMPACT SPEEDS (CALCULATED ONLY)

Length of Time	In Hospital	Bedrest	Restricted from Normal Activity	Work Lost
		Variable		
0 Days	776	640	720	218
1-10 Days	233	173	29	48
11-20 Days	64	24	13	10
3-6 Weeks	64	29	64	7
7-10 Weeks	10	8	19	6
11-20 Weeks	9	0	22	11
More than 5 Months	0	1	6	8
Fatal*	36	47	47	47
Not Applicable	0	0	1	812
Unknown	113	383	383	140
TOTAL	1,305	1,305	1,304	1,307

*Fatal, not admitted for time in hospital variable.

TABLE 5-8. - COST SOURCE DISTRIBUTIONS - 30 MPH OR LOWER IMPACT SPEEDS (ALL SOURCES)

Length of Time	In Hospital	Bedrest	Restricted from Normal Activity	Work Lost
		Variable		
0 Days	3,143	2,295	2,564	699
1-10 Days	769	650	115	271
11-20 Days	194	76	76	62
3-6 Weeks	212	140	148	66
7-10 Weeks	59	42	67	32
11-20 Weeks	33	26	57	49
More than 5 Months	0	6	20	9
Fatal*	121	169	169	169
Not Applicable	10	13	47	2,778
Unknown	521	1,644	1,799	926
TOTAL	5,062	5,061	5,062	5,061

*Fatal, not admitted for time in hospital variable.

TABLE 5-9. - LONG TERM DISABILITY IN 30 MPH OR LOWER IMPACT SPEEDS

Long Term Disability	Calculated Impact Speeds Only	All Sources
Yes	32	123
No	811	2,881
Fatal	47	169
Unknown	415	1,889
Total	1,305	5,062

5.1 Utility of Pedestrian Cost Data

The data summarized in Appendix 4 of this report can be used to define a baseline of the pedestrian accidents, against which proposed countermeasures can be compared. "Pro-pedestrian" front end configurations cannot, however, be evaluated solely on the basis of the present data, since no vehicles with soft front structures were included within the sample.

6. REFERENCES

1. Braisted, R.C., Garrett, J.W., and Hendricks, D.L., "Pedestrian Injury Causation Parameters - Phase I," Report No. DOT-HS-805 689, September 1980. Contract No. DOT-HS-7-01578.

2. Baird, J.D., Didion, J., and Heffernan, A., "Pedestrian Injury Causation Parameters," Dynamic Science, Inc., Report No. DOT-HS-805-652, June 1980. Contract No. DOT-HS-8-01823.

3. Durham III, A.M., Moore, W., and Knoblauch, R.L., "Pedestrian Injury Causation Parameters," BioTechnology, Inc., May 1980. Report No. DOT-HS-805-651, May 1980. Contract No. DOT-HS-8-01824.

4. Lawrason, G.C., Swiercinsky, T.H., and Mason, R.H., "Pedestrian Injury Causation Study," Southwest Research Institute, Report No. DOT-HS-805-653, June 1980. Contract No. DOT-HS-7-01580.

5. Schmidt, D.N., Ravani, B., and Brougham, D., "Pedestrian Injury Causation Study," Traffic Safety Research Corporation, Report No. DOT-HS-805-650, August 1980. Contract No. DOT-HS-7-01581.

6. Toth, G.R., Parada, L.O., Garrett, J.W., Hendricks, D.L., Baum, A.S., and Scheifflee, T.G., "Documentation for the Data File of the Pedestrian Injury Causation Study," U.S. Department of Transportation, National Highway Traffic Safety Administration, February 1981.

7. "The Abbreviated Injury Scale (AIS)," 1976 Revision, Including Dictionary. Developed by a Joint Committee of The American Medical Association, The Society of Automotive Engineers, The American Association for Automotive Medicine.

8. SAS Institute, Inc., "SAS User's Guide, 1979 Edition," prepared by the SAS Institute, Inc., Raleigh, North Carolina, 1979.

9. Blodgett, R., U.S. Department of Transportation, National Highway Traffic Safety Administration, personal communication, July 30, 1980.

10. Knoblauch, R.L., "Urban Pedestrian Accident Countermeasures Experimental Evaluation, Volume II Accident Studies," BioTechnology, Inc., February 1975. Report No. DOT-HS-801-347.

11. Baker, S.P., et al, "The Injury Severity Score: A Method for Describing Patients with Multiple Injuries and Evaluating Emergency Care," Journal of Trauma, March 1974.

12. Ashton, S.J. and Mackay, G.M., "Car Design for Pedestrian Injury Minimization," published in the Seventh International Technical Conference on Experimental Safety Vehicles, Paris, France, June 5-8, 1979.

13. Stcherbatcheff, G., "Pedestrian Protection: Special Features of the Renault E.P.U.R.E., published in the Seventh International Technical Conference on Experimental Safety Vehicles, Paris, France, June 5-8, 1979.

14. Fargin, B.M., "1975 Societal Costs of Motor Vehicle Accidents," 1975.

APPENDIX 1

Computation of Sampling Fractions

Calspan Phase I

This sampling plan consisted of two sampling areas which were "active" on alternate weeks. The plan lasted for 92 days (August 1, 1977 to 9 PM, October 31, 1977), and consisted of an eight-day cycle -- five days on, three off. The first four work days were on the 1 PM to 9 PM shift; the fifth day was either a morning (7 AM - 1 PM) or night (9 PM - 4 AM) shift. The 92 day sampling period consisted of 11 full cycles plus an additional four days on the 1 PM - 9 PM shift.

For 1 PM - 9 PM shift:

$$\left(4\ \frac{\text{days}}{\text{cycle}}\right) \times\ 11\ \text{cycles}\ +\ 4\ \text{additional days} = 48\ \text{days}$$

$$\text{Sampling Fraction (S.F.)} = \left[\frac{\text{24 days sampled}}{\text{92 days possible}}\right]^{-1} = 3.8$$

For 7 AM - 1 PM shift:

Data collected in Area II on the fifth day of 2nd, 6th, and 10th cycles. Data collected in Area I on the fifth day of 3rd, 7th, and 11th cycles. Thus, 3 days were sampled in each area.

$$\text{S.F.} = \left[\frac{\text{3 days sampled}}{\text{92 days possible}}\right]^{-1} = 30.7$$

For 9 PM - 4 AM shift:

Data collected in Area I on fifth day of 1st, 5th, and 9th cycle. Data collected in Area II on fifth day of 4th and 8th cycle.

$$\text{S.F. for Area I} = \left[\frac{\text{3 days sampled}}{\text{92 days possible}}\right]^{-1} = 30.7$$

$$\text{S.F. for Area II} = \left[\frac{\text{2 days sampled}}{\text{92 days possible}}\right]^{-1} = 46.0$$

Calspan Phase II

The sampling plan for Phase II divided the sample area into a core area and two supplementary areas which were sampled on alternate weeks with adjustments for holidays. As was discussed in the Section 2.2, one could not distinguish whether City of Buffalo accidents occurred in the core or supplemental data collection area; hence, an adjustment was applied to the sampling fraction. The plan was in effect from 9 PM October 31, 1977 to March 31, 1979 and consisted of 73 Sundays and Mondays, and 74 Tuesdays through Saturdays. Data were not collected during Thanksgiving and Christmas weeks of 1977 and 1978 nor on Memorial Day 1978, July 4, 1978, Labor Day 1978, and New Year's Day 1979. As a result, the distributions of days sampled in the three areas were:

Days	Time	Area I	Area II	Core
Monday - Friday* (one day per week)	9 PM - 7 AM	36	34	70
Monday	7 AM - 3 PM	34	32	66
Tuesday	1 PM - 9 PM	36	33	69
Wednesday - Friday	1 PM - 9 PM	36	34	70
Saturday } one weekend per month	1 PM - 9 PM	10	7	17
Sunday } one weekend per month	1 PM - 9 PM	7	10	17

*As defined by the end of the shift.

For Monday - Friday, 7 AM - 1 PM (not the entire shift):

The total number of Mondays - Fridays available was:

73 Mons. + 74 Tues. + 74 Weds. + 74 Thurs. + 74 Fris. = 369

Data collected in Area I:

34 Mons. + 0 (Tues. - Fris.) = 34 days

Data collected in Area II:

32 Mons. + 0 (Tues. - Fris.) = 32 days

Data collected in Core region:

Area I + Area II = 34 + 32 = 66 days

S.F. for suburban part of Area I $= \left[\dfrac{\text{34 days sampled}}{\text{369 days possible}}\right]^{-1} = 10.9$

S.F. for suburban part of Area II $= \left[\dfrac{\text{32 days sampled}}{\text{369 days possible}}\right]^{-1} = 11.5$

Adj. S.F. for City of Buffalo $= \dfrac{2}{3}\left[\dfrac{\text{66 days sampled}}{\text{369 days possible}}\right]^{-1} + \dfrac{1}{9}(10.9) + \dfrac{2}{9}(11.5) = 7.5$

For Monday - Friday, 1 PM - 3 PM:

Data collected in Area I:

34 Mons. + 36 Tues. + 36 Weds. + 36 Thurs. + 36 Fris. = 178 days

Data collected in Area II:

32 Mons. + 33 Tues. + 34 Weds. + 34 Thurs. + 34 Fris. = 167 days

Data collected in Core region:

Area I + Area II = 178 + 167 = 345 days

Total Number of Mon - Fri's available:

73 Mons. + 74 Tues. + 74 Weds. + 74 Thurs. + 74 Fris. = 369 days

S.F. for suburban part of Area I $= \left[\dfrac{\text{178 days sampled}}{\text{369 days possible}}\right]^{-1} = 2.1$

S.F. for suburban part of Area II $= \left[\dfrac{\text{167 days sampled}}{\text{369 days possible}}\right]^{-1} = 2.2$

Adj. S.F. for City of Buffalo $= \dfrac{2}{3}\left[\dfrac{\text{345 days sampled}}{\text{369 days possible}}\right]^{-1} + \dfrac{1}{9}(2.1) + \dfrac{2}{9}(2.2) = 1.4$

For Monday - Friday, 9 PM - 7 AM (next day)*:

Data collected in Area I one day in each of the 36 "active" weeks, or 36 days.

Data collected in Area II one day in each of the 34 "active" weeks, or 34 days.

Data collected in Core Region = Area I + Area II or 70 days.

Total number of Mon. - Fris. during sample plan = 369 days.

S.F. for suburban part of Area I $= \left[\frac{36 \text{ days sampled}}{369 \text{ days possible}}\right]^{-1} = 10.3$

S.F. for suburban part of Area II $= \left[\frac{34 \text{ days sampled}}{369 \text{ days possible}}\right]^{-1} = 10.9$

Adj. S.F. for City of Buffalo $= \frac{2}{3}\left[\frac{70 \text{ days sampled}}{369 \text{ days possible}}\right]^{-1} + \frac{1}{9}(10.3) + \frac{2}{9}(10.9) = 7.1$

For Monday - Friday, 3 PM - 9 PM:

Data collected in Area I:

0 Mons. + 36 Tues. + 36 Weds. + 36 Thurs. + 36 Fris. = 144 days

Data collected in Area II:

0 Mons. + 33 Tues. + 34 Weds. + 34 Thurs. + 34 Fris. = 135 days

Data collected in Core Region = Area I + Area II = 279 days

Total number of days available:

73 Mons. + 74 Tues. + 74 Weds. + 74 Thurs. + 74 Fris. = 369 days

S.F. for suburban part of Area I $= \left[\frac{144 \text{ days sampled}}{369 \text{ days possible}}\right]^{-1} = 2.6$

S.F. for suburban part of Area II $= \left[\frac{135 \text{ days sampled}}{369 \text{ days possible}}\right]^{-1} = 2.7$

Adj. S.F. for City of Buffalo $= \frac{2}{3}\left[\frac{279 \text{ days sampled}}{369 \text{ days possible}}\right]^{-1} + \frac{1}{9}(2.6) + \frac{2}{9}(2.7) = 1.8$

* This includes 9:00 PM Sunday to 7 AM Monday and excludes 9 PM Friday to 7 AM Saturday.

For Saturdays and Sundays, 1 PM - 9 PM:

Data collected in Area I:

November 13, 1977; December 4, 1977; January 15, 1978; February 18, 1978; March 18, 1978; April 9, 1978; May 21, 1978; June 24, 1978; July 16, 1978; August 19, 1978; September 16, 1978; October 14, 1978; November 19, 1978; December 16, 1978; January 20, 1979; February 17, 1979; and March 17, 1979, or 17 days.

Data collected in Area II:

November 12, 1977; December 3, 1977; January 14, 1978; February 19, 1978; March 19, 1978; April 8, 1978; May 20, 1978; June 25, 1978; July 15, 1978; August 20, 1978; September 17, 1978; October 15, 1978; November 18, 1978; December 17, 1978; January 21, 1979; February 18, 1979; and March 18, 1979, or 17 days.

Total number of days available:

73 Suns. + 74 Sats. = 147 days

Data Collected in Core Region: Area I + Area II, or 17 days

S.F. for suburban part of Area I $= \left[\frac{17 \text{ days sampled}}{147 \text{ days possible}}\right]^{-1} = 8.6$

S.F. for suburban part of Area II $= \left[\frac{17 \text{ days sampled}}{147 \text{ days possible}}\right]^{-1} = 8.6$

Adj. S.F. for City of Buffalo $= \frac{2}{3}\left[\frac{34 \text{ days sampled}}{147 \text{ days possible}}\right]^{-1} + \frac{1}{9}(8.6) + \frac{2}{9}(8.6) = 5.8$

Calspan Phase III

The third sample plan employed by Calspan eliminated subdividing the data collection area; the entire region was sampled. The sampling times used in Calspan Phase II were still applicable and the following additions were made:

- Accidents occurring between 4 AM and 1 PM Tuesday through Friday and 3 PM and 11 PM Monday were collected (on a follow-on basis) every other week as were pedestrian accidents taking place between 9 PM and 4 AM (the next day), Tuesday through Friday and 11 PM (Sunday) through 7 AM Monday.

- Data from approximately half the remaining weekend days (all 24 hours) were collected on a follow-on basis.

This particular sample plan was in effect from April 1, 1979 to the conclusion of data collection on February 14, 1980. It comprised 320 days (46 Sundays through Thursdays and 45 Fridays and Saturdays); the data were not collected during the Thanksgiving and Christmas weeks of 1979, nor on Memorial Day 1979 (a Monday), July 4th, 1979 (a Wednesday), Labor Day 1979 (a Monday), and New Year's Day 1980 (a Tuesday). Thus, there were 44 Sundays and Thursdays, 43 Tuesdays, Wednesdays, Fridays, and Saturdays, and 42 Mondays on which the data collection team was in the field.

The total number of weekdays available for collection was:

46 Mons. + 46 Tues. + 46 Weds. + 46 Thurs. + 45 Fris. = 229 days

For Monday - Friday, Midnight - 4 AM:

Data were collected on 88 days, i.e., 22 Mons. + 0 Tues. + 22 Weds. + 22 Thurs. + 22 Fris.

$$S.F. = \left[\frac{88 \text{ days sampled}}{229 \text{ days possible}}\right]^{-1} = 2.6$$

For Monday - Friday, 4 AM - 7 AM:

Data were collected on 107 days, i.e., 22 Mons. + 21 Tues. + 21 Weds. + 22 Thurs. + 21 Fris.

$$S.F. = \left[\frac{107 \text{ days sampled}}{229 \text{ days possible}}\right]^{-1} = 2.1$$

For Monday - Friday, 7 AM - 1 PM:

Data were collected on 127 days, i.e., 42 Mons. + 21 Tues. + 21 Weds. + 22 Thurs. + 21 Fris.

$$S.F. = \left[\frac{127 \text{ days sampled}}{229 \text{ days possible}}\right]^{-1} = 1.8$$

For Monday - Friday, 1 PM - 3 PM:

Data were collected on 215 days, i.e., 42 Mons. + 43 Tues. + 43 Weds. + 44 Thurs. + 43 Fris.

$$S.F. = \left[\frac{215 \text{ days sampled}}{229 \text{ days possible}}\right]^{-1} = 1.1$$

For Monday - Friday, 3 PM - 9 PM:

Data were collected on 194 days, i.e., 21 Mons. + 43 Tues. + 43 Weds. + 44 Thurs. + 43 Fris.

$$S.F. = \left[\frac{194 \text{ days sampled}}{229 \text{ days possible}}\right]^{-1} = 1.2$$

For Monday - Friday, 9 PM - 11 PM:

Data were collected on 109 days, i.e., 21 Mons. + 22 Tues. + 22 Weds. + 22 Thurs. + 22 Fris.

$$S.F. = \left[\frac{109 \text{ days sampled}}{229 \text{ days possible}}\right]^{-1} = 2.1$$

For Monday - Friday, 11 PM - Midnight:

Data were collected on 88 days, i.e., 0 Mons. + 22 Tues. + 22 Weds. + 22 Thurs. + 22 Fris.

$$S.F. = \left[\frac{88 \text{ days sampled}}{229 \text{ days possible}}\right]^{-1} = 2.6$$

For Saturday and Sunday, 1 PM - 9 PM

Data collected on-scene one week per month (except February 1980) = 20 days = 20 days

Plus the following days (on a follow-on basis):

<u>1979</u>: April 15; April 21; April 22; April 28; May 5; May 6; May 13; June 2; June 3; June 16; June 17; July 7; July 8; July 28; July 29; August 4; August 5; August 25; August 26; September 8; September 9; September 29; September 30; October 13; October 14; October 27; October 28; November 10; November 11; November 24; November 25; December 8; December 9;

<u>1980</u>: January 5; January 6; January 26; January 27; February 9; and February 10 = <u>39</u> days

TOTAL 59 days

Total days available:

46 Sundays + 45 Saturdays = 91 days

$$S.F. = \left[\frac{59 \text{ days sampled}}{91 \text{ days possible}}\right]^{-1} = 1.5$$

For Saturday and Sunday, 4 AM - 1 PM and 9 PM - 11 PM

Data for these time periods were collected on a follow-on basis on the following dates:

<u>1979</u>: April 15; April 21; April 22; April 28; May 5; May 6; May 13; June 2; June 3; June 16; June 17; July 7; July 8; July 28; July 29; August 4; August 5; August 25; August 26; September 8; September 9; September 29; September 30; October 13; October 14; October 27; October 28; November 10; November 11; November 24; November 25; December 8; December 9

<u>1980</u>: January 5; January 6; January 26; January 27; February 9; and February 10 = 39 days

$$S.F. = \left[\frac{39 \text{ days sampled}}{91 \text{ days possible}}\right]^{-1} = 2.3$$

For Saturday and Sunday, Midnight - 4 AM:

This particular time period could be eligible either as part of a Friday 9 PM - 4 AM follow-on data collection interval or as an all-day Saturday or Sunday follow-on collection interval. The specific Saturday dates (and the basis for collection) are:

Saturdays	"Fridays, 9 PM - 4 AM"	Both	
1979:	1979:	1979:	
April 28; July 7; August 4; September 29; October 13; October 27; November 10; November 24	April 7; May 19; June 30, July 14; August 11; September 22; October 6; October 20; November 3; November 17; December 22	April 21, May 5; June 2; June 16; July 28; August 25; September 8; December 8	
1980:	1980:	1980:	
January 5; February 9	January 12; February 2	January 26	= 32 days

Plus the Sunday follow-on days = 20 days

TOTAL 52 days

$$S.F. = \left[\frac{52 \text{ days sampled}}{91 \text{ days possible}}\right]^{-1} = 1.8$$

For Saturday and Sunday, 11 PM - Midnight:

Data could be collected during this time period either as a result of a Saturday or Sunday with 24 hour follow-on coverage or a Monday with coverage from 11 PM - 7 AM. The specific Sunday dates and their respective bases were:

Sundays	"Mondays, 11 PM-7 AM"	Both
1979:	1979:	1979:
April 15; May 13; July 8; August 5; September 30; October 14; October 28; November 11; November 25	April 8; May 20; July 1; July 15; August 12; September 23; October 7; October 21; November 4; December 30	April 22; May 6; June 3; June 17; July 29; August 26; September 9; December 9
1980:	1980:	1980:
January 6; February 10	January 13; February 3	January 27

= 32 days

Plus the Saturday follow-on days = 19 days

TOTAL 51 days

$$S.F. = \left[\frac{51 \text{ days sampled}}{91 \text{ days possible}}\right]^{-1} = 1.8$$

Southwest Research Institute (SWRI) Phase I

SWRI had a sampling plan which employed a twenty-week cycle. Each day was divided into four time periods. These time periods were sampled differently on weekends (7 PM Friday - 7 AM Monday) than they were during the week. The plan was structured in such a way that the sampling fraction could be calculated directly from the sampling rate (by inversion) as long as the plan's duration (in weeks) was evenly divisible by twenty. This was the case for SWRI's original plan, which lasted exactly twenty weeks; i.e., August 29, 1977 - January 15, 1978. The table below presents the sample rate and corresponding sampling fraction for each sampling interval.

Time of Day		Sample Rate	Sample Fraction
Monday - Friday	1 AM - 7 AM	.2	5
Monday - Friday	7 AM - 1 PM	.25	4
Monday - Friday	1 PM - 7 PM	.5	2
Monday - Thursday	7 PM - 1 AM (the next day)	.2	5
Saturday - Monday	1 AM - 7 AM	.2	5
Saturday, Sunday	7 AM - 1 PM	.2	5
Saturday, Sunday	1 PM - 7 PM	.2	5
Saturday, Sunday	7 PM - 1 AM (the next day)	.2	5

SWRI Phase II

The second SWRI sampling scheme was essentially a continuation of the first, except the sampling rates for the Monday - Friday 7 AM - 1 PM and 1 PM - 7 PM shifts were both increased to .6. The duration of the sampling was 91 weeks, in other words, four complete cycles plus 11 weeks. Truncating the sampling plan short of a complete cycle had little effect on the weekday sampling fraction. The sampling rates were satisfied within any given week, e.g., sampling three days a week resulted in a .6 sample rate, one day per week was .2. What was affected, was the number of times each day of the week was included. Thus, there may be more Mondays from

1 PM - 7 PM sampled than Tuesdays at the comparable time. This was believed to be an insignificant variation, and was consequently ignored. Thus, the weekday sampling fractions could be determined directly from the sample rates. Accordingly:

Time of Day		Sample Rate	Sample Fraction
Monday - Friday	1 AM - 7 AM	.2	5
Monday - Friday	7 AM - 1 PM	.6	1.7
Monday - Friday	1 PM - 7 PM	.6	1.7
Monday - Friday	7 PM - 1 AM (the next day)	.2	5

This was not the case with weekends. In order to compute the sampling fraction directly, the length of the sampling plan's duration had to be evenly divisible by five. Since 91 (weeks) is not, the occurrence of each shift for each day had to be counted, and the sampling fraction was based on the frequency and the number of possible Saturdays and Sundays, viz., 182.

Time of Day	Number of Occurrences in 91 Week	Sampling Fraction
1 AM - 7 AM	37	4.9
7 AM - 1 PM	37	4.9
1 PM - 7 PM	37	4.9
7 PM - 1 AM (the next day)	36	5.1

SWRI Phase III

The last sample plan lasted from October 15, 1979 to February 21, 1980, a total of 94 days. The period between 7 AM and 7 PM, Monday - Friday, was sampled in its entirety; thus, the sampling fraction of 1.0. The other two shifts on the weekdays were both sampled 19 times out of the 94 days duration. Hence:

$$\text{S.F.} = \left[\frac{\text{19 days sampled}}{\text{94 days possible}}\right]^{-1} = 4.9$$

Similarly, each of the weekend shifts were sampled seven times during the eighteen weekends (36 days) included in the last phase.

$$S.F. = \left[\frac{7 \text{ days sampled}}{36 \text{ days possible}}\right]^{-1} = 5.1$$

Dynamic Science, Phase I

Dynamic Science incorporated a straightforward sampling strategy, wherein each of four shifts were sampled consecutively on a four day "on", 1 day "off" basis. The shifts were: 5 AM - 11 AM, 11 AM - 5 PM, 5 PM - 11 PM, and 11 PM - 5 AM the next day. This required a one hundred-forty day cycle in order to sample each of the days of the week and each shift the same number of times. The plan lasted for 360 days (March 15, 1978 - March 9, 1979. Thus, each shift was sampled 18 times out of the 72 cycles within the first phase.

The sampling fraction for all shifts is:

Data collected on 4 days during each of 18 cycles, or 72 days, 72 cycles, or 360 days within sample plan

$$S.F. = \left[\frac{72 \text{ days sampled}}{360 \text{ days possible}}\right]^{-1} = 5.0$$

Dynamic Science Phases II and III

The second phase differed from the first sampling plan only in that the 5 PM - 11 PM shift was sampled during its assigned cycles plus cycles in which the 11 PM - 5 AM shift was active. The second phase lasted from March 10, 1979 to May 31, 1979 when the third phase was initiated. The sampling strategy, however, did not change* so the two phases (from March 10, 1979 to March 3, 1980) can be treated as a single entity. The

* Only the sampling area changed; see discussion in Section 2.2.

360 day sample duration was considered to be sufficiently long so that the day of week by shift imbalance was not significant. The phases comprised 18 cycles of the 11 AM - 5 PM and the 11 PM - 5 AM shifts, 36 of the 5 PM - 11 PM shift, and 18 of the 5 AM - 11 AM shift during the 72 cycles included within the plan's duration.

For 5 AM - 11 AM, 11 AM - 5 PM and 11 PM - 5 AM shifts:

Data were collected on four days in each of the 18 cycles, or 72 days out of 360.

$$S.F. = \left[\frac{72 \text{ days sampled}}{360 \text{ days possible}}\right]^{-1} = 5.0$$

For 5 PM - 11 PM shift:

Data were collected on four days in each of 36 cycles, or 144 days.

$$S.F. = \left[\frac{144 \text{ days sampled}}{360 \text{ days possible}}\right]^{-1} = 2.5$$

Traffic Safety Research (TSR) Phase I and Phase II

TSR used an 8 week cyclical sampling strategy. There was a "core" sampling time Monday - Saturday which ran from noon - 8 PM; on half of these days, either an 8 AM - Noon shift was added, or else an 8 PM - 10 PM sampling interval was appended. Every third week, accidents occurring between Noon and 8 PM, Sundays were collected. Furthermore, accidents which happened from 10 PM - 4 AM Friday night/Saturday morning and Saturday night/Sunday morning were investigated every fifth week.

The first plan was in effect for 23 weeks, after which the 8 AM to Noon shift was expanded to 7 AM to Noon. Since that hour had not been included in the first phase, it was believed that no problems would arise if both phases were treated as a single entity.

Thus, the computation of the sampling fractions was based on a sampling strategy which lasted for 133 weeks. This consists of 16 complete cycles and five additional weeks. The individual calculations are provided below.

For Noon - 8 PM time interval Monday - Saturday

Data were collected on 36 days in each of the 16 cycles plus 22 days in the first five weeks of the 17th cycle, or 598 days;

These were sampled from a time period consisting of 133 weeks with 6 days per week, or 798 days.

$$S.F. = \left[\frac{598 \text{ days sampled}}{798 \text{ days possible}}\right]^{-1} = 1.3$$

For 8 AM (7 AM in Phase II) - Noon and 8 PM - 10 PM time intervals, Monday - Saturday

Data were collected on 18 days in each of the 16 cycles plus 11 days in the first five weeks of the 17th cycle, or 299 days.

$$S.F. = \left[\frac{299 \text{ days sampled}}{798 \text{ days possible}}\right]^{-1} = 2.7$$

For Sundays, Noon - 8 PM

There were 44 Sundays on which data were collected.

$$S.F. = \left[\frac{44 \text{ Sundays sampled}}{133 \text{ Sundays possible}}\right]^{-1} = 3.0$$

For 10 PM - 4 AM Friday/Saturday and Saturday/Sunday.

There were 26 "weekends" on which data were collected during these hours.

$$\text{S.F.} = \left[\frac{\text{26 "weekends" sampled}}{\text{133 "weekends" possible}}\right]^{-1} = 5.1$$

BioTechnology Phase I

The sampling plan used initially by BioTechnology was implemented for a period of 53 weeks; lasting from April 9, 1978 to April 14, 1979. Each week was assigned to either following-up (completing) investigations, or on-scene investigations from one of the following time intervals: 7 AM - 3 PM; 3 PM - 11 PM; and 11 PM - 7 AM (the next day). There was no systematic method by which the applicable shifts/follow-on work were assigned; each will be listed when appropriate.

For 7 AM - 3 PM shift:

Data were collected during the twelve weeks listed below:

April 9 - April 15, 1978
May 7 - May 13, 1978
June 4 - June 10, 1978
August 6 - August 12, 1978
September 3 - September 9, 1978
October 1 - October 7, 1978
October 29 - November 4, 1978
November 26 - December 2, 1978
December 24 - December 30, 1978
January 21 - January 27, 1979
February 18 - February 24, 1979
March 18 - March 24, 1979

$$\text{S.F.} = \left[\frac{\text{12 weeks sampled}}{\text{53 weeks possible}}\right]^{-1} = 4.4$$

For 3 PM - 11 PM shift:

Data were collected during the twelve weeks listed below:

April 23 - April 29, 1978	November 12 - November 18, 1978
May 21 - May 27, 1978	December 10 - December 16, 1978
July 23 - July 29, 1978	January 7 - January 13, 1979
August 20 - August 26, 1978	February 4 - February 10, 1979
September 17 - September 23, 1978	March 4 - March 10, 1979
October 15 - October 21, 1978	April 1 - April 7, 1979

$$S.F. = \left[\frac{\text{12 weeks sampled}}{\text{53 weeks possible}}\right]^{-1} = 4.4$$

For 11 PM - 7 AM shift:

Data were collected during the four weeks listed below:

June 18 - June 24, 1978	October 22 - October 28, 1978
June 25 - July 1, 1978	October 29 - November 4, 1978

$$S.F. = \left[\frac{\text{4 weeks sampled}}{\text{53 weeks possible}}\right]^{-1} = 13.2$$

5.2 BioTechnology Phase II

The second sampling plan used by BioTechnology started April 15, 1979 and lasted until December 29, 1979 (37 weeks). Accidents occurring between the hours of 1 PM - 9 PM were investigated every even numbered week day. On the first seven days of each month, data from accidents which took place between 9 PM and 1 PM the next day were collected. The first two weekend days of each month were sampled from 1 PM - 9 PM.

For 1 PM - 9 PM Weekdays

From a calendar, it can be determined that there were 91 even-numbered weekdays.

During the period of Phase II, there were 185 weekdays.

$$S.F. = \left[\frac{91 \text{ days sampled}}{185 \text{ days possible}} \right]^{-1} = 2.0$$

For 9 PM - 1 PM the next day, Weekdays:

There were 8 months from which the first week was sampled, or 56 days.

Phase II contained 259 days.

$$S.F. = \left[\frac{56 \text{ days sampled}}{259 \text{ days possible}} \right]^{-1} = 4.6$$

For 1 PM - 9 PM Weekends:

There were 8 months from which the first two weekend days were sampled, or 16 days.

$$S.F. = \left[\frac{16 \text{ days sampled}}{74 \text{ days possible}} \right]^{-1} = 4.6$$

```
***;
*     THE OBJECT OF THIS PROGRAM IS TO PUT WEIGHT FACTOR ON THE PICS FILE.;
***;
DATA FATPED;
SET DISK11.HUMAN;
KEEP TEAM YEAR MONTH SEQ FATALPED PDNO;
***;
*     THIS FIRST PORTION OF THE PROGRAM DETERMINES WHETHER A PEDESTRIAN IN THE;
* ACCIDENT WAS KILLED. FIRST EACH PED IS EXAMINED.;
***;
IF BEDREST = 97 OR OTHREST = 97 OR WORKLOST = 97 THEN FATALPED = 1;
        ELSE FATALPED = 2;
      LABEL FATALPED='WAS PED KILLED? 1 = YES, 2 = NO';
PROC SORT DATA = FATPED;
      BY TEAM YEAR MONTH SEQ;
DATA FATACC;
SET FATPED;
      BY TEAM YEAR MONTH SEQ;
RETAIN FATALACC;
KEEP TEAM YEAR MONTH SEQ FATALACC;
IF FIRST.YEAR = 1 OR FIRST.TEAM = 1 OR FIRST.MONTH = 1 OR FIRST.SEQ = 1 THEN
      FATALACC = 2;
      IF FATALPED = 1 THEN FATALACC = 1;
      IF LAST.TEAM = 1 OR LAST.YEAR = 1 OR LAST.MONTH = 1 OR LAST.SEQ = 1 THEN
      OUTPUT;
      LABEL FATALACC='DID ACCIDENT KILL A PED? 1 = YES, 2 = NO';
DATA FACC;
MERGE DISK11.ACC(IN=VAR) FATACC(IN=VAR1);
      BY TEAM YEAR MONTH SEQ;
KEEP TEAM YEAR MONTH SEQ FATALACC FRACTION PLAN;
      IF YEAR NE 0 THEN XYEAR = YEAR + 70; ELSE XYEAR = YEAR + 80;
      IF VAR = 1 AND VAR1 = 1;
***;
*     WE ARE NOW READY TO APPEND A WEIGHT FACTOR TO THE ACCIDENT.;
***;
      IF FATALACC = 1 AND TEAM NE 7 THEN FRACTION = 1;
      LABEL FRACTION='WEIGHTING FACTOR';
      IF FATALACC = 1 AND TEAM NE 7 THEN RETURN;
      IF TEAM = 1 THEN LINK TEAMONE;
      IF TEAM = 6 THEN LINK TEAMSIX;
      IF TEAM = 7 THEN LINK TEAMSEV;
      IF TEAM = 8 THEN LINK TEAMEIG;
      IF TEAM = 9 THEN LINK TEAMNIN;
      RETURN;
TEAMONE:
***;
*     TEAM ONE IS CALSPAN OF BUFFALO, NEW YORK. CALSPAN HAD THREE;
* DIFFERENT SAMPLING PLANS OVER DIFFERENT TIME INTERVALS.;
*     THE FIRST PLAN LASTED FROM AUGUST 1, 1977 TO 9 PM OCTOBER 31, 1977;
*     THE SECOND PLAN LASTED FROM 9 PM OCTOBER 31, 1977 TO MARCH 31, 1979;
*     THE THIRD PLAN LASTED FROM APRIL 1, 1979 TO 9 PM FEBRUARY 14, 1980;
***;
      DDONE = JULDATE(MDY(MONTH,DATE,XYEAR));
      DDTWO = JULDATE(MDY(10,31,77));
      DDTHR = JULDATE(MDY(3,31,79));
      IF DDONE LT DDTWO THEN LINK PLANC1;
      IF DDONE GT DDTWO AND DDONE LE DDTHR THEN LINK PLANC2;
      IF DDONE GT DDTHR THEN LINK PLANC3;
      IF DDONE = DDTWO AND TIME GE 2100 THEN LINK PLANC2;
      IF DDONE = DDTWO AND TIME LT 2100 THEN LINK PLANC1;
      RETURN;
```

```
PLANC1:
PLAN=1;
***;
*     THIS SECTION DEALS WITH CALSPANS FIRST SAMPLING PLAN.;
***;
      X = INT((DDONE-JULDATE(MDY(8,1,77)))/8); Y = X/2; Z = Y - INT(Y);
      IF TIME GT 1300 AND TIME LE 2100 THEN DO;
         FRACTION=3.8;
         RETURN;
         END;
      IF TIME GT 0700 AND TIME LE 1300 THEN FRACTION = 30.7;
      IF (TIME LE 0700 OR TIME GT 2100) AND Z = 0 THEN FRACTION = 30.7;
      IF (TIME LE 0700 OR TIME GT 2100) AND Z NE 0 THEN FRACTION = 46;
      RETURN;
PLANC2:
PLAN=2;
***;
*     THIS SECTION DEALS WITH CALSPAN'S SECOND SAMPLING PLAN;
***;
***;
*     SUBDIVISION OF BUFFALO, ALTHOUGH NECESSARY, IS NOT POSSIBLE;
* WITH THE DATA ON THE FILE. THUS THE OBSERVATIONS FROM BUFFALO ARE;
* WEIGHTED AS FOLLOWES;
*     2/3 CORE + 1/9 TONAWANDA + 2/9 CHEEKTOWAGA;
*
*     BUFFALO = 0750029;
*     CHEEKTOWAGA = 1117029;
*     TONAWANDA = 6090029;
***;
      IF DAY GE 2 AND DAY LE 6 AND TIME GT 0000 AND TIME LE 0700 THEN DO;
         IF JURIS=0750029 THEN FRACTION=7.1;
         IF JURIS=1117029 THEN FRACTION=10.9;
         IF JURIS NE 0750029 AND JURIS NE 1117029 THEN FRACTION=10.3;
         RETURN;   END;
      IF DAY GE 2 AND DAY LE 6 AND TIME GT 0700 AND TIME LE 1300 THEN DO;
         IF JURIS=0750029 THEN FRACTION=7.5;
         IF JURIS=1117029 THEN FRACTION=11.5;
         IF JURIS NE 0750029 AND JURIS NE 1117029 THEN FRACTION=10.9;
         RETURN;   END;
      IF DAY GE 2 AND DAY LE 6 AND TIME GT 1300 AND TIME LE 1500 THEN DO;
         IF JURIS=0750029 THEN FRACTION=1.4;
         IF JURIS=1117029 THEN FRACTION=2.2;
         IF JURIS NE 0750029 AND JURIS NE 1117029 THEN FRACTION=2.1;
         RETURN;   END;
      IF DAY GE 2 AND DAY LE 6 AND TIME GT 1500 AND TIME LE 2100 THEN DO;
         IF JURIS=0750029 THEN FRACTION=1.8;
         IF JURIS=1117029 THEN FRACTION=2.7;
         IF JURIS NE 0750029 AND JURIS NE 1117029 THEN FRACTION=2.6;
         RETURN;   END;
      IF DAY GE 1 AND DAY LE 5 AND TIME GT 2100 AND TIME LE 2400 THEN DO;
         IF JURIS=0750029 THEN FRACTION=7.1;
         IF JURIS=1117029 THEN FRACTION=10.9;
         IF JURIS NE 0750029 AND JURIS NE 1117029 THEN FRACTION=10.3;
         RETURN;   END;
      IF (DAY=1 OR DAY=7) AND (TIME GE 900 AND TIME LE 2100) THEN DO;
         IF JURIS=0750029 THEN FRACTION=5.8;
         ELSE FRACTION=8.6;
            END;
      RETURN;
PLANC3:
PLAN=3;
```

```
***;
*     THIS SECTION DEALS WITH CALSPAN'S THIRD SAMPLING PLAN.;
***;
      IF DAY GE 2 AND DAY LE 6 THEN DO;
         IF TIME GT 0000 AND TIME LE 0400 THEN FRACTION=2.6;
         IF TIME GT 0400 AND TIME LE 0700 THEN FRACTION=2.1;
         IF TIME GT 0700 AND TIME LE 1300 THEN FRACTION=1.8;
         IF TIME GT 1300 AND TIME LE 1500 THEN FRACTION=1.1;
         IF TIME GT 1500 AND TIME LE 2100 THEN FRACTION=1.2;
         IF TIME GT 2100 AND TIME LE 2300 THEN FRACTION=2.1;
         IF TIME GT 2300 AND TIME LE 2400 THEN FRACTION=2.6;
         RETURN;
         END;
      IF DAY=1 OR DAY=7 THEN DO;
         IF TIME GT 0000 AND TIME LE 0400 THEN FRACTION=1.8;
         IF TIME GT 0400 AND TIME LE 1300 THEN FRACTION=2.3;
         IF TIME GT 1300 AND TIME LE 2100 THEN FRACTION=1.5;
         IF TIME GT 2100 AND TIME LE 2300 THEN FRACTION=2.3;
         IF TIME GT 2300 AND TIME LE 2400 THEN FRACTION=1.8;
            END;
      RETURN;
TEAMSIX:
***;
*       TEAM SIX IS SWRI SAMPLING FROM SAN ANTONIO, TEXAS.  SWRI HAD THREE;
*      DIFFERENT SAMPLING PLANS OVER DIFFERENT TIME INTERVALS.;
*     THE FIRST PLAN LASTED FROM AUGUST 29, 1977 TO JANUARY 15, 1978.;
*     THE SECOND PLAN LASTED FROM JANUARY 16, 1978 TO OCTOBER 14, 1979.;
*     THE THIRD PLAN LASTED FROM OCTOBER 15, 1979 TO FEBRUARY 21, 1980.;
***;
      DDONE = JULDATE(MDY(MONTH,DATE,XYEAR));
      DDTWO = JULDATE(MDY(1,15,78));
      DDTHR = JULDATE(MDY(10,15,79));
      IF DDONE LE DDTWO THEN LINK PLANS1;
      IF DDONE GT DDTWO AND DDONE LT DDTHR THEN LINK PLANS2;
      IF DDONE GE DDTHR THEN LINK PLANS3;
      RETURN;
PLANS1:
PLAN=4;
***;
*     THIS SECTION DEALS WITH SWRI'S FIRST SAMPLING PLAN.;
***;
      IF DAY GE 2 AND DAY LE 6 AND TIME GT 1300 AND TIME LE 1900 THEN DO;
         FRACTION=2; RETURN;
         END;
      FRACTION = 5;
      IF DAY GE 2 AND DAY LE 6 AND TIME GT 0700 AND TIME LE 1300 THEN
          FRACTION = 4;
      RETURN;
PLANS2:
PLAN=5;
***;
*     THIS SECTION DEALS WITH SWRI'S SECOND SAMPLING PLAN.;
***;
      IF DAY GE 2 AND DAY LE 6 THEN FRACTION=5;
      IF DAY GE 2 AND DAY LE 6 AND TIME GT 0700 AND TIME LE 1900 THEN
         FRACTION=1.7;
      IF DAY = 1 OR DAY = 7 THEN FRACTION = 5.1;
      IF (DAY = 1 OR DAY = 7) AND (TIME GT 0100 AND TIME LE 1900) THEN
         FRACTION = 4.9;
      RETURN;
PLANS3:
```

```
PLAN=6;
***;
*      THIS SECTION DEALS WITH SWRI'S THIRD SAMPLING PLAN.,
***;
       IF DAY GE 2 AND DAY LE 6 THEN FRACTION=4.9;
       IF DAY GE 2 AND DAY LE 6 AND TIME GT 0700 AND TIME LE 1900 THEN
          FRACTION=1;
       IF DAY=1 OR DAY=7 THEN FRACTION=5.1;
       RETURN;
TEAMSEV:
***;
*      TEAM SEVEN IS DSI SAMPLING FROM LOS ANGELES, CALIFORNIA.;
*      DSI HAD THREE SAMPLING PLANS.  THE FIRST WAS FROM MARCH 15, 1978 TO;
*      MARCH 9, 1979.  THE OTHER TWO SAMPLING PLANS DEAL WITH SUBSECTIONS OF THE;
*      AREA CONSIDERED IN THE FIRST PLAN.  THE SECOND PLAN LASTS FROM ;
*      MARCH 10, 1979 TO MAY 31, 1979.  THE THIRD PLAN LASTS FROM JUNE 1, 1979;
*      TO MARCH 3, 1980.;
***;
       DDONE = JULDATE(MDY(MONTH,DATE,XYEAR));
       DDTWO = JULDATE(MDY(3,9,79));
       IF DDONE LE DDTWO THEN LINK PLAND1;
       IF DDONE GT DDTWO THEN LINK PLAND2;
***;
*      ALTHOUGH THERE WERE TWO DIFFERENT REGIONS THAT SHOULD HAVE DIFFERENT;
*      WEIGHTS, THEY ARE NOT DISTINGUISHABLE ON THE FILE.;
***;
       RETURN;
PLAND1:
PLAN=7;
***;
*      THIS SECTION DEALS WITH DSI'S FIRST SAMPLING PLAN.;
***;
       FRACTION=5;
       RETURN;
PLAND2:
PLAN=8;
***;
*      THIS SECTION DEALS WITH DSI'S SECOND SAMPLING PLAN.;
***;
       IF TIME GT 1700 AND TIME LE 2300 THEN FRACTION = 2.5;  ELSE FRACTION=5;
       RETURN;
TEAMEIG:
***;
*      TEAM EIGHT IS TSR SAMPLING FROM SAN JOSE, CALIFORNIA.;
*      TSR HAD TWO SAMPLING PLANS.  THE FIRST LASTED FROM ;
*      AUGUST 8, 1977 TO JANUARY 15, 1978  THE SECOND DEALS WITH AN;
*      OTHER AREA AND LASTS FROM JANUARY 16, 1978 TO FEBRUARY 25, 1980.;
*      BUT THE WEIGHTS ARE THE SAME FOR BOTH REGIONS.;
***;
PLAN=9;
       IF DAY GE 2 AND DAY LE 7 AND TIME GT 1200 AND TIME LE 2000 THEN DO;
          FRACTION = 1.3; RETURN;
          END;
       IF DAY = 1 THEN FRACTION = 3;
       IF DAY GE 2 AND DAY LE 7 THEN FRACTION = 2.7;
       IF TIME GT 2200 OR TIME LE 0400 THEN FRACTION = 5.1;
       RETURN;
TEAMNIN:
***;
*      TEAM NINE IS BTI SAMPLING FROM WASHINGTON, D.C.;
*      BTI HAD TWO SAMPLING PLANS THAT COVERED DIFFERENT TIME PERIODS;
```

```
*     THE FIRST WAS FROM APRIL 9, 1978 TO APRIL 14, 1979 AND THE SECOND;
*     WAS FROM APRIL 15, 1979 TO DECEMBER 29, 1979.;
***;
      DDONE = JULDATE(MDY(MONTH,DATE,XYEAR));
      DDTWO = JULDATE(MDY(4,14,79));
      IF DDONE LE DDTWO THEN LINK PLANB1;
      IF DDONE GT DDTWO THEN LINK PLANB2;
      RETURN;
PLANB1:
PLAN=10;
***;
*     THIS SECTION DEALS WITH BTI'S FIRST SAMPLING PLAN;
***;
      IF TIME GT 1500 AND TIME LE 2300 THEN FRACTION=4.4; ELSE DO;
         IF TIME GT 0700 AND TIME LE 1500 THEN FRACTION=4.4;
         ELSE FRACTION=13.2;
         END;
      RETURN;
PLANB2:
PLAN=11;
***;
*     THIS SECTION DEALS WITH BTI'S SECOND SAMPLING PLAN;
***;
      IF TIME GT 1300 AND TIME LE 2100 THEN FRACTION=2.0;
      ELSE FRACTION=4.6;
      IF TIME=1300 AND DAY LE 7 THEN FRACTION=2.0;
      RETURN;
*;
DATA WORK.ONE;
MERGE DISK11.ACC (IN=IN1) FACC (IN=IN2);
BY TEAM YEAR MONTH SEQ;
IF NOT (IN1 AND IN2) THEN DELETE;
PROC SORT DATA=WORK.ONE OUT=PED.ACC; BY TEAM;
PROC DELETE DATA=WORK.ONE;
DATA WORK.ONE;
MERGE DISK11.VEH (IN=IN1) FACC (IN=IN2);
BY TEAM YEAR MONTH SEQ;
IF NOT(IN1 AND IN2) THEN DELETE;
PROC SORT DATA=WORK.ONE OUT=PED.VEH;
BY TEAM YEAR MONTH SEQ VNO;
PROC DELETE DATA=WORK.ONE;
DATA WORK.ONE;
MERGE DISK11.ACCSEQ (IN=IN1) FACC (IN=IN2);
BY TEAM YEAR MONTH SEQ;
IF NOT(IN1 AND IN2) THEN DELETE;
PROC SORT DATA=WORK.ONE OUT=PED.ACCSEQ;
BY TEAM YEAR MONTH SEQ VNO PDNO;
PROC DELETE DATA=WORK.ONE;
DATA WORK.ONE;
MERGE DISK11.HUMAN (IN=IN1) FACC (IN=IN2);
BY TEAM YEAR MONTH SEQ;
IF NOT(IN1 AND IN2) THEN DELETE;
PROC SORT DATA=WORK.ONE OUT=PED.HUMAN;
BY TEAM YEAR MONTH SEQ PDNO;
PROC DELETE DATA=WORK.ONE;
DATA WORK.ONE;
MERGE DISK11.CONTACT (IN=IN1) FACC (IN=IN2);
BY TEAM YEAR MONTH SEQ;
IF NOT(IN1 AND IN2) THEN DELETE;
PROC SORT DATA=WORK.ONE OUT=PED.CONTACT;
BY TEAM YEAR MONTH SEQ VNO PDNO;
```

The number of variables and observations in the data files are as follows:

Data Level	Data Set Label	Number of Observations	Number of Variables
accident	ACC	1,997	60
vehicle	VEH	2,021	53
accident sequence	ACCSEQ	2,092	120
human	HUMAN	2,068	108
contact	CONTACT	2,092	48

PICS DATA FILE CONTENTS

Accident Level (ACC)

Variable No.	Name	Description/Label
1	TEAM	TEAM
2	YEAR	YEAR
3	MONTH	MONTH
4	TIME	TIME
5	RESPTM	TEAM RESPONSE TIME
6	ACCLOC	AREA OF ACCIDENT
7	FRACTION	WEIGHTING FACTOR
8	FATALACC	DID ACCIDENT KILL A PED? 1 = YES, 2 = NO
9	DAY	DAY OF WEEK
10	POLSOR	SOURCE OF NOTIFICATION
11	INVTYP	TYPE OF INVESTIGATION
12	ACCTYPE	ACCIDENT TYPE
13	NOVEH	NUMBER OF VEHICLES
14	NOPED	NUMBER OF PEDESTRIANS
15	OASV1	VEHICLE 1 OBSERVED AT SCENE
16	OASV2	VEHICLE 2 OBSERVED AT SCENE
17	OASP1	PED. 1 OBSERVED AT SCENE
18	OASP2	PED. 2 OBSERVED AT SCENE
19	OASP3	PED. 3 OBSERVED AT SCENE
20	ALCOHOL	POLICE REPORTED ALCOHOL INVOLVEMENT
21	BACD1	BLOOD ALCOHOL DRIVER 1
22	BACD2	BLOOD ALCOHOL DRIVER 2
23	BACP1	BLOOD ALCOHOL PED. 1
24	BACP2	BLOOD ALCOHOL PED. 2
25	BACP3	BLOOD ALCOHOL PED. 3
26	BACTD1	TYPE OF BAC TEST-DRIVER 1
27	BACTD2	TYPE OF BAC TEST-DRIVER 2
28	BACTP1	TYPE OF BAC TEST-PED 1
29	BACTP2	TYPE OF BAC TEST-PED 2
30	BACTP3	TYPE OF BAC TEST-PED 3
31	MAXPINJ	HIGHEST PED. OVERALL AIS
32	MAXPISS	HIGHEST PED. ISS
33	NFATAL	NUMBER OF FATALS
34	ZONE	ZONE
35	INTERS	INTERSECTION TYPE
36	TRAFCONT	TRAFFIC CONTROL
37	LIGHT	LIGHT CONDITION
38	ARTLITE	ARTIFICIAL LIGHTING
39	FUNCCLS	FUNCTIONAL CLASSIFICATION AT SITE
40	NOLANE	NUMBER OF LANES
41	OCCURIN	ACCIDENT OCCURRED IN
42	SPEEDLIM	POSTED SPEED LIMIT
43	HALIGN	HORIZONTAL ALIGNMENT
44	VALIGN	VERTICAL ALIGNMENT
45	SURTYPE	SURFACE TYPE
46	SURCOND	SURFACE CONDITION
47	SURCOV	WEATHER RELATED SURFACE CONDITIONS
48	WEATHER	WEATHER
49	EDGETYPE	EDGE TYPE

ZS-6117-V-1

Accident Level (ACC)

Variable No.	Name	Description/Label
50	MU1	COEFFICIENT OF FRICTION 1
51	MU2	COEFFICIENT OF FRICTION 2
52	MU3	COEFFICIENT OF FRICTION 3
53	VACT	VEH ACTIVITY PRIOR TO ACCIDENT
54	VELDATA	VELOCITY DATA
55	AVOIDMAN	ATTEMPTED AVOIDANCE MANEUVER
56	ORIENTA	VEH, ORIENTATION AT IMPACT
57	SEASON	SEASON OF THE YEAR
58	INVDATE	DAYS FROM ACCIDENT TO INVESTIGATION
59	INVTIME	TIME (MIN) FROM ACCIDENT TO INVESTGATION
60	CASENO	ACCIDENT CASE NUMBER

Vehicle Level (VEH)

Variable No.	Name	Description/Label
1	FRACTION	WEIGHTING FACTOR
2	FATALACC	DID ACCIDENT KILL A PED? 1 = YES, 2 = NO
3	DRAGE	DRIVER AGE
4	DRSEX	DRIVER SEX
5	DRALCUSE	DRIVER ALCOHOL USE
6	DRBAC	DRIVER BAC
7	NOCHAR	NUMBER VIN CHARACTERS
8	VIN	VEH. ID. NUMBER
9	CPIR	COLLISION PERFORMANCE & INJURY REP. CODE
10	MILEAGE	ODOMETER READING
11	MODYEAR	MODEL YEAR
12	BODSTYLE	BODY STYLE
13	VCURBWT	VEHICLE CURB WEIGHT
14	VOCC_CRG	VEHICLE OCCUPANT & CARGO WEIGHT
15	TOTWGT	TOTAL VEHICLE WEIGHT
16	TOWING	TOWING OTHER VEHICLE?
17	OBJCON1	FIRST OBJECT CONTACTED
18	DOF1	DIRECTION OF FORCE 1
19	CDCGAD1	GENERAL AREA OF DAMAGE 1
20	CDCSHL1	SPECIFIC HORIZONTAL LOCATION 1
21	CDCSVA1	SPECIFIC VERTICAL AREA 1
22	CDCTDD1	TYPE OF DAMAGE DISTRIBUTION 1
23	EXTENT1	EXTENT OF DAMAGE 1
24	IMPNO1	IMPACT NUMBER 1
25	OBJCON2	SECOND OBJECT CONTACTED
26	DOF2	DIRECTION OF FORCE 2
27	CDCGAD2	GENERAL AREA OF DAMAGE 2
28	CDCSHL2	SPECIFIC HORIZONTAL LOCATION 2
29	CDCSVA2	SPECIFIC VERTICAL AREA 2
30	CDCTDD2	TYPE OF DAMAGE DISTRIBUTION 2
31	EXTENT2	EXTENT OF DAMAGE 2
32	IMPNO2	IMPACT NUMBER 2
33	OBJCON3	THIRD OBJECT CONTACTED
34	DOF3	DIRECTION OF FORCE 3
35	CDCGAD3	GENERAL AREA OF DAMAGE 3
36	CDCSHL3	SPECIFIC HORIZONTAL LOCATION 3
37	CDCSVA3	SPECIFIC VERTICAL AREA 3
38	CDCTDD3	TYPE OF DAMAGE DISTRIBUTION 3
39	EXTENT3	EXTENT OF DAMAGE 3
40	IMPNO3	IMPACT NUMBER 3
41	BUMPHT	BUMPER HEIGHT
42	CONTHT	CONTACT HEIGHT
43	HOODHT	HOOD HEIGHT
44	BUMPLD	BUMPER LEAD
45	HOODLNG	HOOD LENGTH
46	SIDEPROT	SIDE PROTRUSION
47	BELTLINE	BELTLINE
48	RBUMPHT	REAR BUMPER HEIGHT
49	TRUNKHT	TRUNK HEIGHT
50	LEADANG	BUMPER LEAD ANGLE
51	VEHNO	VEHICLE NUMBER
52	TSPEED	CALCULATED TRAVEL SPEED
53	CASENO	ACCIDENT CASE NUMBER

ZS-6117-V-1

Accident Sequence Level (ACCSEQ)

Variable No.	Name	Description/Label
1	FRACTION	WEIGHTING FACTOR
2	TRVDIRPI	PRE-IMPACT TRAVEL DIRECTION
3	TRVLANPI	PRE-IMPACT TRAVEL LANE
4	TRVSPDPI	PRE-IMPACT TRAVEL SPEED
5	VACTPI	PRE-IMPACT VEHICLE ACTIVITY
6	VELDATPI	PRE-IMPACT VELOCITY DATA
7	AVOIDPI	PRE-IMPACT AVOIDANCE MANEUVER
8	ACCSITE	ACCIDENT SITE
9	PEDLOC	PEDESTRIAN LOCATION
10	PEDTRDIP	PEDESTRIAN TRAVEL DIRECTION
11	PEDACTIV	PEDESTRIAN ACTIVITY
12	ATTITUDE	PEDESTRIAN ATTITUDE
13	PEDMOT	TYPE OF PEDESTRIAN MOTION
14	PEDARTT	PED. ACTION RELATIVE TO TRAFFIC
15	BORIERTT	BODY ORIENTATION RELATIVE TO TRAFIC
16	PEDAVOID	PEDESTRIAN AVOIDANCE MANEUVER
17	SPEEDEST	SPEED ESTIMATE
18	ERRANGE	ERROR RANGE OF SPEEDEST
19	DATSORC	DATA SOURCE OF SPEEDEST
20	VLOCIMP	VEHICLE LOCATION AT IMPACT
21	TRVLANIM	TRAVEL LANE AT IMPACT
22	TRVDIRIM	VEHICLE TRAVEL DIRECTION AT IMPACT
23	BODORIMP	BODY ORIENTATION AT IMPACT
24	HEADPOIM	HEAD ORIENTATION AT IMPACT
25	ARMPOIMP	ARM ORIENTATION AT IMPACT
26	LEGPOIMP	LEG ORIENTATION AT IMPACT
27	BOARCN1	BODY AREA CONTACTED--IMPACT 1
28	VN1	VEHICLE NUMBER INVOLVED--IMPACT 1
29	VIMPLC1	LOCATION ON VEHICLE OF IMPACT 1
30	VIMPOR1	VEHICLE ORIENTATION AT IMPACT 1
31	UN1	VEHICLE NUMBER IN (NON-PED) IMPACT 1
32	UIMPLC1	LOCATION ON VEHICLE OF (NON-PED) IMP 1
33	UIMPOR1	VEHICLE ORIENTATION AT (NON-PED) IMP 1
34	UOBJCN1	OBJECT CONTACTED--(NON-PED) IMPACT 1
35	BOARCN2	BODY AREA CONTACTED--IMPACT 2
36	VN2	VEHICLE NUMBER INVOLVED--IMPACT 2
37	VIMPLC2	LOCATION ON VEHICLE OF IMPACT 2
38	VIMPOR2	VEHICLE ORIENTATION AT IMPACT 2
39	UN2	VEHICLE NUMBER IN (NON-PED) IMPACT 2
40	UIMPLC2	LOCATION ON VEHICLE OF (NON-PED) IMP 2
41	UIMPOR2	VEHICLE ORIENTATION AT (NON-PED) IMP 2
42	UOBJCN2	OBJECT CONTACTED--(NON-PED) IMPACT 2
43	BOARCN3	BODY AREA CONTACTED--IMPACT 3
44	VN3	VEHICLE NUMBER INVOLVED--IMPACT 3
45	VIMPLC3	LOCATION ON VEHICLE OF IMPACT 3
46	VIMPOR3	VEHICLE ORIENTATION AT IMPACT 3
47	UN3	VEHICLE NUMBER IN (NON-PED) IMPACT 3
48	UIMPLC3	LOCATION ON VEHICLE OF (NON-PED) IMP 3

ZS-6117-V-1

Accident Sequence Level (ACCSEQ)

Variable No.	Name	Description/Label
49	UIMPOR3	VEHICLE ORIENTATION AT (NON-PED) IMP 3
50	UOBJCN3	OBJECT CONTACTED--(NON-PED) IMPACT 3
51	BOAPCN4	BODY AREA CONTACTED--IMPACT 4
52	VN4	VEHICLE NUMBER INVOLVED--IMPACT 4
53	VIMPLC4	LOCATION ON VEHICLE OF IMPACT 4
54	VIMPOR4	VEHICLE ORIENTATION AT IMPACT 4
55	UN4	VEHICLE NUMBER IN (NON-PED) IMPACT 4
56	UIMPLC4	LOCATION ON VEHICLE OF (NON-PED) IMP 4
57	UIMPOR4	VEHICLE ORIENTATION AT (NON-PED) IMP 4
58	UOBJCN4	OBJECT CONTACTED--(NON-PED) IMPACT 4
59	BOARCN5	BODY AREA CONTACTED--IMPACT 5
60	VN5	VEHICLE NUMBER INVOLVED--IMPACT 5
61	VIMPLC5	LOCATION ON VEHICLE OF IMPACT 5
62	VIMPOR5	VEHICLE ORIENTATION AT IMPACT 5
63	UN5	VEHICLE NUMBER IN (NON-PED) IMPACT 5
64	UIMPLC5	LOCATION ON VEHICLE OF (NON-PED) IMP 5
65	UIMPOR5	VEHICLE ORIENTATION AT (NON-PED) IMP 5
66	UOBJCN5	OBJECT CONTACTED--(NON-PED) IMPACT 5
67	BOAPCN6	BODY AREA CONTACTED--IMPACT 6
68	VN6	VEHICLE NUMBER INVOLVED--IMPACT 6
69	VIMPLC6	LOCATION ON VEHICLE OF IMPACT 6
70	VIMPOR6	VEHICLE ORIENTATION AT IMPACT 6
71	UN6	VEHICLE NUMBER IN (NON-PED) IMPACT 6
72	UIMPLC6	LOCATION ON VEHICLE OF (NON-PED) IMP 6
73	UIMPOR6	VEHICLE ORIENTATION AT (NON-PED) IMP 6
74	UOBJCN6	OBJECT CONTACTED--(NON-PED) IMPACT 6
75	BOARCN7	BODY AREA CONTACTED--IMPACT 7
76	VN7	VEHICLE NUMBER INVOLVED--IMPACT 7
77	VIMPLC7	LOCATION ON VEHICLE OF IMPACT 7
78	VIMPOR7	VEHICLE ORIENTATION AT IMPACT 7
79	UN7	VEHICLE NUMBER IN (NON-PED) IMPACT 7
80	UIMPLC7	LOCATION ON VEHICLE OF (NON-PED) IMP 7
81	UIMPOR7	VEHICLE ORIENTATION AT (NON-PED) IMP 7
82	UOBJCN7	OBJECT CONTACTED--(NON-PED) IMPACT 7
83	BOAPCN8	BODY AREA CONTACTED--IMPACT 8
84	VN8	VEHICLE NUMBER INVOLVED--IMPACT 8
85	VIMPLC8	LOCATION ON VEHICLE OF IMPACT 8
86	VIMPOR8	VEHICLE ORIENTATION AT IMPACT 8
87	UN8	VEHICLE NUMBER IN (NON-PED) IMPACT 8
88	UIMPLC8	LOCATION ON VEHICLE OF (NON-PED) IMP 8
89	UIMPOR8	VEHICLE ORIENTATION AT (NON-PED) IMP 8
90	UOBJCN8	OBJECT CONTACTED--(NON-PED) IMPACT 8
91	BOAPCN9	BODY AREA CONTACTED--IMPACT 9
92	VN9	VEHICLE NUMBER INVOLVED--IMPACT 9
93	VIMPLC9	LOCATION ON VEHICLE OF IMPACT 9
94	VIMPOR9	VEHICLE ORIENTATION AT IMPACT 9
95	UN9	VEHICLE NUMBER IN (NON-PED) IMPACT 9
96	UIMPLC9	LOCATION ON VEHICLE OF (NON-PED) IMP 9

Accident Sequence Level (ACCSEQ)

Variable No.	Name	Description/Label
97	UIMPOR9	VEHICLE ORIENTATION AT (NON-PED) IMP 9
98	UOBJCN9	OBJECT CONTACTED--(NON-PED) IMPACT 9
99	BOARCN10	BODY AREA CONTACTED--IMPACT 10
100	VN10	VEHICLE NUMBER INVOLVED--IMPACT 10
101	VIMPLC10	LOCATION ON VEHICLE OF IMPACT 10
102	VIMPOR10	VEHICLE ORIENTATION AT IMPACT 10
103	UN10	VEHICLE NUMBER IN (NON-PED) IMPACT 10
104	UIMPLC10	LOCATION ON VEHICLE OF (NON-PED) IMP 10
105	UIMPOR10	VEHICLE ORIENTATION AT (NON-PED) IMP 10
106	UOBJCN10	OBJECT CONTACTED--(NON-PED) IMPACT 10
107	DRINPUTS	DRIVER INPUTS BETWEEN LAST POI & FRP
108	IPOI_FRP	DISTANCE BETWEEN INITIAL POI & FRP (VEH)
109	FPOI_FRP	DISTANCE BETWEEN LAST POI & FRP (VEH)
110	FRPOS	VEHICLE FRP
111	IIMP_FRP	DISTANCE BETWEEN FIRST POI & FRP (PED)
112	FIMP_FRP	DISTANCE BETWEEN FINAL POI & FRP (PED)
113	FRPOSPED	PEDESTRIAN FRP
114	VEH_PEDI	VEHICLE/PEDESTRIAN INTERACTION
115	GVAC	GROSS VEHICLE AREA CONTACTED
116	PEDNO	PEDESTRIAN NUMBER
117	VEHNO	VEHICLE NUMBER
118	FATALACC	DID ACCIDENT KILL A PED? 1 = YES, 2 = NO
119	FATALPED	WAS PED KILLED? 1 = YES, 2 = NO
120	CASENO	ACCIDENT CASE NUMBER

Human Level (HUMAN)

Variable No.	Name	Description/Label
1	FRACTION	WEIGHTING FACTOR
2	FATALACC	DID ACCIDENT KILL A PED? 1 = YES, 2 = NO
3	VISITS	OUTPATIENT VISITS
4	BEDREST	DAYS BEDREST
5	OTHREST	DAYS OTHER RESTRICTION
6	WORKLOST	WORKDAYS LOST
7	HOSPDAYS	DAYS HOSPITALIZED
8	LTDISAB	LONG TERM DISABILITIES
9	MORETEN	MORE THAN 10 INJURIES?
10	CONNO1	CONTACT NUMBER--INJURY 1
11	BODREG1	BODY REGION--INJURY 1
12	ASPECT1	ASPECT--INJURY 1
13	LESION1	LESION--INJURY 1
14	SYSORG1	SYSTEM/ORGAN--INJURY 1
15	AIS1	AIS--INJURY 1
16	SOURCE1	INJURY SOURCE--INJURY 1
17	ICDA1	ICDA CODE--INJURY 1
18	CONNO2	CONTACT NUMBER--INJURY 2
19	BODREG2	BODY REGION--INJURY 2
20	ASPECT2	ASPECT--INJURY 2
21	LESION2	LESION--INJURY 2
22	SYSORG2	SYSTEM/ORGAN--INJURY 2
23	AIS2	AIS--INJURY 2
24	SOURCE2	INJURY SOURCE--INJURY 2
25	ICDA2	ICDA CODE--INJURY 2
26	CONNO3	CONTACT NUMBER--INJURY 3
27	BODREG3	BODY REGION--INJURY 3
28	ASPECT3	ASPECT--INJURY 3
29	LESION3	LESION--INJURY 3
30	SYSORG3	SYSTEM/ORGAN--INJURY 3
31	AIS3	AIS--INJURY 3
32	SOURCE3	INJURY SOURCE--INJURY 3
33	ICDA3	ICDA CODE--INJURY 3
34	CONNO4	CONTACT NUMBER--INJURY 4
35	BODREG4	BODY REGION--INJURY 4
36	ASPECT4	ASPECT--INJURY 4
37	LESION4	LESION--INJURY 4
38	SYSORG4	SYSTEM/ORGAN--INJURY 4
39	AIS4	AIS--INJURY 4
40	SOURCE4	INJURY SOURCE--INJURY 4
41	ICDA4	ICDA CODE--INJURY 4

ZS-6117-V-1

Human Level (HUMAN)

Variable No.	Name	Description/Label
42	CONNO5	CONTACT NUMBER--INJURY 5
43	BODREG5	BODY REGION--INJURY 5
44	ASPECT5	ASPECT--INJURY 5
45	LESION5	LESION--INJURY 5
46	SYSORG5	SYSTEM/ORGAN--INJURY 5
47	AIS5	AIS--INJURY 5
48	SOURCE5	INJURY SOURCE--INJURY 5
49	ICDA5	ICDA CODE--INJURY 5
50	CONNO6	CONTACT NUMBER--INJURY 6
51	BODREG6	BODY REGION--INJURY 6
52	ASPECT6	ASPECT--INJURY 6
53	LESION6	LESION--INJURY 6
54	SYSORG6	SYSTEM/ORGAN--INJURY 6
55	AIS6	AIS--INJURY 6
56	SOURCE6	INJURY SOURCE--INJURY 6
57	ICDA6	ICDA CODE--INJURY 6
58	CONNO7	CONTACT NUMBER--INJURY 7
59	BODREG7	BODY REGION--INJURY 7
60	ASPECT7	ASPECT--INJURY 7
61	LESION7	LESION--INJURY 7
62	SYSORG7	SYSTEM/ORGAN--INJURY 7
63	AIS7	AIS--INJURY 7
64	SOURCE7	INJURY SOURCE--INJURY 7
65	ICDA7	ICDA CODE--INJURY 7
66	CONNO8	CONTACT NUMBER--INJURY 8
67	BODREG8	BODY REGION--INJURY 8
68	ASPECT8	ASPECT--INJURY 8
69	LESION8	LESION--INJURY 8
70	SYSORG8	SYSTEM/ORGAN--INJURY 8
71	AIS8	AIS--INJURY 8
72	SOURCE8	INJURY SOURCE--INJURY 8
73	ICDA8	ICDA CODE--INJURY 8
74	CONNO9	CONTACT NUMBER--INJURY 9
75	BODREG9	BODY REGION--INJURY 9
76	ASPECT9	ASPECT--INJURY 9
77	LESION9	LESION--INJURY 9
78	SYSORG9	SYSTEM/ORGAN--INJURY 9
79	AIS9	AIS--INJURY 9
80	SOURCE9	INJURY SOURCE--INJURY 9
81	ICDA9	ICDA CODE--INJURY 9

Human Level (HUMAN)

Variable No.	Name	Description/Label
82	CONNO10	CONTACT NUMBER--INJURY 10
83	BODREG10	BODY REGION--INJURY 10
84	ASPECT10	ASPECT--INJURY 10
85	LESION10	LESION--INJURY 10
86	SYSORG10	SYSTEM/ORGAN--INJURY 10
87	AIS10	AIS--INJURY 10
88	SOURCE10	INJURY SOURCE--INJURY 10
89	ICDA10	ICDA CODE--INJURY 10
90	OVERAIS	OVERALL AIS
91	ISS	INJURY SEVERITY SCORE
92	PEDAGE	PEDESTRIAN AGE
93	PEDSEX	PEDESTRIAN SEX
94	PALCINV	PEDESTRIAN ALCOHOL INVOLVEMENT
95	PEDHGT	PEDESTRIAN HEIGHT
96	PEDWGT	PEDESTRIAN WEIGHT
97	GR_KNEE	GROUND TO KNEE HEIGHT
98	GR_HIP	GROUND TO HIP HEIGHT
99	GR_SHLDR	GROUND TO SHOULDER HEIGHT
100	NECKLENG	NECK LENGTH
101	HEELHGT	SHOE HEEL HEIGHT
102	INJSTAT	INJURY STATUS
103	TREATMNT	TREATMENT
104	PEDBAC	PEDESTRIAN BAC
105	PBACTYPE	PEDESTRIAN BAC TEST TYPE
106	PEDNO	PEDESTRIAN NUMBER
107	FATALPED	WAS PED KILLED? 1 = YES, 2 = NO
108	CASENO	ACCIDENT CASE NUMBER

Contact Level (CONTACT)

Variable No.	Name	Description/Label
1	FRACTION	WEIGHTING FACTOR
2	WRAP1	WRAP DISTANCE 1
3	COMPLOC1	COMPONENT LOCATION 1
4	COMCON1	COMPONENT CONTACTED 1
5	STRPRO1	STRIKING PROFILE 1
6	TYPDAM1	TYPE OF DAMAGE 1
7	DAMEXT1	DAMAGE EXTENT 1
8	CONTNO1	CONTACT NUMBER 1
9	WRAP2	WRAP DISTANCE 2
10	COMPLOC2	COMPONENT LOCATION 2
11	COMCON2	COMPONENT CONTACTED 2
12	STRPRO2	STRIKING PROFILE 2
13	TYPDAM2	TYPE OF DAMAGE 2
14	DAMEXT2	DAMAGE EXTENT 2
15	CONTNO2	CONTACT NUMBER 2
16	WRAP3	WRAP DISTANCE 3
17	COMPLOC3	COMPONENT LOCATION 3
18	COMCON3	COMPONENT CONTACTED 3
19	STRPRO3	STRIKING PROFILE 3
20	TYPDAM3	TYPE OF DAMAGE 3
21	DAMEXT3	DAMAGE EXTENT 3
22	CONTNO3	CONTACT NUMBER 3
23	WRAP4	WRAP DISTANCE 4
24	COMPLOC4	COMPONENT LOCATION 4
25	COMCON4	COMPONENT CONTACTED 4
26	STRPRO4	STRIKING PROFILE 4
27	TYPDAM4	TYPE OF DAMAGE 4
28	DAMEXT4	DAMAGE EXTENT 4
29	CONTNO4	CONTACT NUMBER 4
30	WRAP5	WRAP DISTANCE 5
31	COMPLOC5	COMPONENT LOCATION 5
32	COMCON5	COMPONENT CONTACTED 5
33	STRPRO5	STRIKING PROFILE 5
34	TYPDAM5	TYPE OF DAMAGE 5
35	DAMEXT5	DAMAGE EXTENT 5
36	CONTNO5	CONTACT NUMBER 5
37	WRAP6	WRAP DISTANCE 6
38	COMPLOC6	COMPONENT LOCATION 6
39	COMCON6	COMPONENT CONTACTED 6
40	STRPRO6	STRIKING PROFILE 6
41	TYPDAM6	TYPE OF DAMAGE 6
42	DAMEXT6	DAMAGE EXTENT 6
43	CONTNO6	CONTACT NUMBER 6
44	PEDNO	PEDESTRIAN NUMBER
45	VEHNO	VEHICLE NUMBER
46	FATALACC	DID ACCIDENT KILL A PED? 1 = YES, 2 = NO
47	FATALPED	WAS PED KILLED? 1 = YES, 2 = NO
48	CASENO	ACCIDENT CASE NUMBER

APPENDIX 2

Photography Instructions

PHOTOGRAPHY

Case photographs provide useful documentation of details of pedestrian contacts with the vehicle, vehicle damage and scene data. They are also essential in the quality control program as a means of assuring consistency in classifying data from team to team. If necessary, photographs can also be used for re-evaluation of cases or subject areas of special interest in subsequent data analysis.

Case photographs are marked on back with team number, month and case sequence number.

Film

We recommend that Kodak Plus X black and white film, ASA 125, be used. It appears to be the best all around film for this type of photography. Higher speed film has a tendency to produce grainy prints and is generally not acceptable. In most cases, the use of color film will not provide good results because of the lack of contrast between pedestrian contact areas and reflections or highlights.

Case Photographs

A minimum of eight to twelve photographs is required for each case. If vehicle damage is extensive, or if the scene evidence extends over a long distance, additional photographs should be taken. It is difficult to recommend a specific set of photographs. In general, it is wise to determine which angle, direction and lighting will provide the best coverage of scuff marks, scratches, or other damage to the vehicle surface before taking the picture. A hand-held flash unit often will provide more flexibility in this regard than one mounted on the camera, since scuff marks often are better highlighted at an angle than with direct lighting.

Initial photographs at the scene should include both the pedestrian (or mark indicating final rest) and the vehicle at final rest. If the pedestrian is in close proximity to the vehicle, include one photograph taken at a right angle to both the pedestrian and the vehicle. A second photograph showing the pedestrian between the vehicle and the camera should also be taken, i.e., both views should be perpendicular to one another.

After removal of the vehicle, a photograph should be taken at close range along the vehicle path to show tire marks, debris, etc. Point of impact should also be shown and, if the vehicle or pedestrian rest position is some distance away, additional photographs should be taken at intervals along the post-impact trajectory.

APPENDIX 3

Data Collection Forms

IDENTIFICATION

Case Number ____________________
Day ____________________
Date ____________________
Time ____________________
Location ____________________
Accident Type ____________________

DAWN DAY DUSK NIGHT

WEATHER

Clear/dry	Snowing	Cloudy/Overcast
Raining	Fog	Other

ROAD

	Expressway	
Freeway	Arterial	Major
Collector	Local	Other

ROAD SURFACE

Dry	Snow	Surface Water
Damp/Wet	Frost/Ice	Other

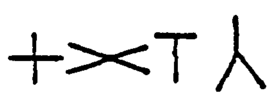
TRAFFIC CONTROLS

None Sign Signal Manual

SPEED LIMIT (KPH)

Actual Value ____________

INTERSECTION

N/A  Multileg

PEDESTRIAN NO. ___
Sex ____________________
Age ____________________
Height ____________________
Weight ____________________
Clothes ____________________

DRIVER
Sex ____________________
Age ____________________

VEHICLE NO. ___
MAKE ____________________
MODEL ____________________ YEAR ________
BODY STYLE ____________________

COMMENTS

LOCATION OF PEDESTRIAN AT IMPACT

In Road - Crossing from Nearside
- Crossing from Offside
- Not Crossing

Not in Road   Other

ACTION OF VEHICLE (PRE-IMPACT)

Going Straight   Turning Left
Reversing   Turning Right

Out of Control - No Previous Impact
- Previous Impact

ACTION OF PEDESTRIAN (PRE-IMPACT)

Stationary
- Standing
- Bending at Waist
- Other

Moving
- Walking
- Running

VEHICLE DECELERATION

No Braking During Accident

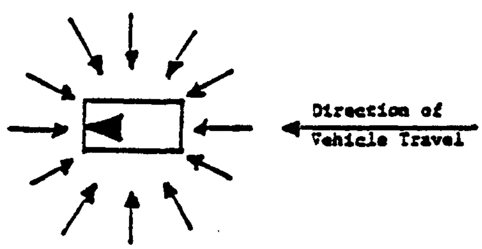
Braking
- Before Impact
- After Impact
- Time Not Known

Skidding
- Before Impact
- After Impact
- Time Not Known

Number of Skid Marks ________
Length of Skid Marks ________ (meters)

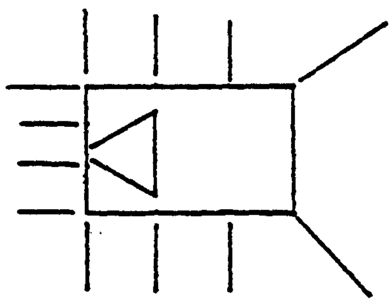
Estimated Travel Speed ____________KPH
Estimated Impact Speed ____________KPH

COLLISION ORIENTATION OF VEHICLE & PEDESTRIAN AT IMPACT

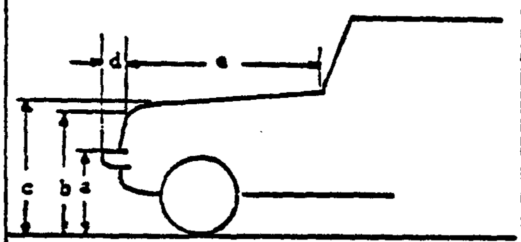


EVENT SEQUENCE/ACCIDENT DESCRIPTION

LOCATION OF FIRST CONTACT ON VEHICLE



VEHICLE FRONT PROFILE IN PLANE OF IMPACT

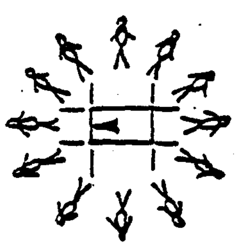


a) BUMPER HEIGHT ________ (CMs)
b) CONTACT HEIGHT ________ (CMs)
c) HOOD HEIGHT ________ (CMs)
d) BUMPER LEAD* ________ (CMs)
e) HOOD LENGTH ________ (CMs)

Distance P.O.I - F.R.P.

Pedestrian ________ (Meters)
Vehicle ________ (Meters)

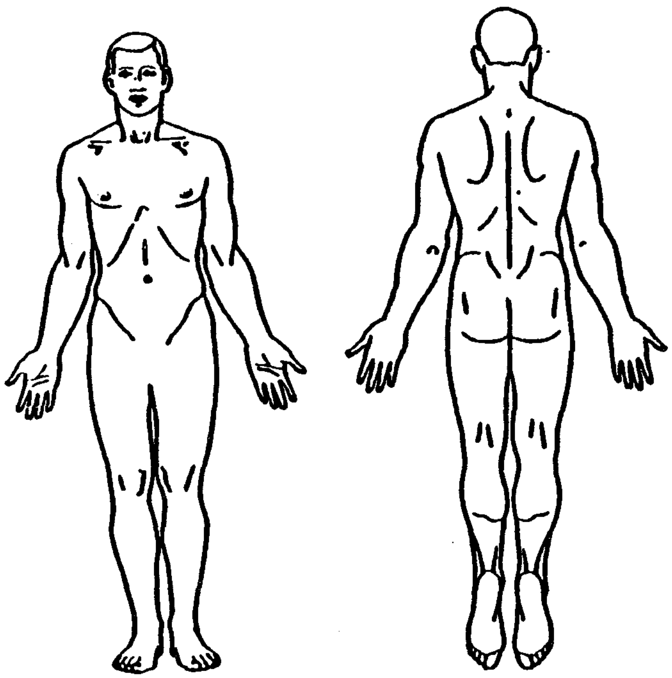
FINAL POSITION OF PEDESTRIAN W.R.T. FINAL POSITION OF VEHICLE



DYNAMICS

*If rear bumper is involved, specify and indicate side protrusion dimension.

SOURCE OF INJURY



Vehicle Photo Indicating
Contact Areas in Sequential Order

<u>Kinematics</u> (Describe the impact, pedestrian movements, contacted areas, trajectory, etc., and relate these to his injuries).

CONTACT AREAS AND INJURIES

BODY AREA	CONTACTING AREA *	INJURY	AIS
ISS ** ◯		Overall AIS	

Photo No. 2 ***

*If the contacting area involves hood ornament, door handle, or side rearview mirror describe (show dimensions, type, etc.) in the "Dynamic" space and insert a "red dot" 2.5 cms in diameter at the right upper corner of the first page.

**Circle the injuries used to determine the ISS.

***Use additional photos if required.

MV-104A (9/79)

State of New York – Department of Motor Vehicles

POLICE ACCIDENT REPORT

DMV COPY

Page____ of ____ Pages

1

Local Codes

19

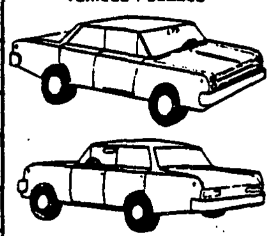
ACCIDENT DATE MO / DA / YR	DAY OF WEEK	TIME ☐ AM ☐ PM	NUMBER OF VEHICLES	NO. INJURED	NO. KILLED	NON-HIGHWAY ☐	NOT INVESTIGATED AT SCENE ☐	LEFT SCENE ☐	POLICE PHOTOS YES ☐ NO ☐

2 20

VEHICLE 1	VEHICLE 2
LAST NAME DRIVER 1 / FIRST NAME / MIDDLE INITIAL	LAST NAME DRIVER 2 / FIRST NAME / MIDDLE INITIAL
NUMBER AND STREET	NUMBER AND STREET
CITY / STATE / ZIP CODE	CITY / STATE / ZIP CODE
DATE OF BIRTH MO / DA / YR / SEX / UNLICENSED ☐ / NUMBER OF OCCUPANTS / PUBLIC PROPERTY DAMAGED ☐ / DMV USE	DATE OF BIRTH MO / DA / YR / SEX / UNLICENSED ☐ / NUMBER OF OCCUPANTS / PUBLIC PROPERTY DAMAGED ☐ / DMV USE
LAST NAME OWNER 1 / FIRST NAME / MIDDLE INITIAL	LAST NAME OWNER 2 / FIRST NAME / MIDDLE INITIAL
NUMBER AND STREET	NUMBER AND STREET
CITY / STATE / ZIP CODE	CITY / STATE / ZIP CODE
PLATE NUMBER / STATE OF REG. / YEAR & VEHICLE MAKE / VEHICLE TYPE / INS. CODE	PLATE NUMBER / STATE OF REG. / YEAR & VEHICLE MAKE / VEHICLE TYPE / INS. CODE

3 21 22 23 4 24

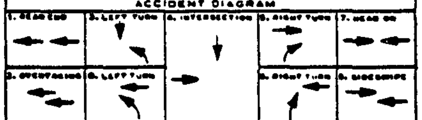
VEHICLE 1 DAMAGE



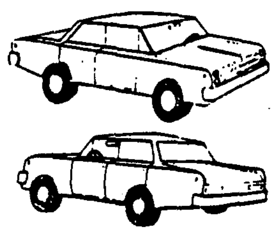
NO DAMAGE ☐ UNDERCARRIAGE ☐

VEHICLE TOWED BY TO

ACCIDENT DIAGRAM



VEHICLE 2 DAMAGE



NO DAMAGE ☐ UNDERCARRIAGE ☐

VEHICLE TOWED BY TO

5 6 7 25 26 27

REFERENCE MARKER	COUNTY	☐ CITY ☐ TOWN ☐ VILLAGE OF	ADDRESS/LANDMARKS AT SCENE
	ROUTE NO. OR STREET NAME ON	☐ MILES ☐ N ☐ E ☐ FEET ☐ S ☐ W OF ☐ AT INTERSECTION WITH	ROUTE NO. OR STREET NAME

28

TICKET/ARREST OPR 1 ☐ PEDESTRIAN ☐ OPR 2 ☐ OTHER ☐	TICKET/ARREST NUMBER(S) VIOLATION SECTION(S)

29

ACCIDENT DESCRIPTION/OFFICER'S NOTES

30

USE COVER SHEET B

ALL INVOLVED		8	9	10	11	12	13	14	15	16	17	18	NAMES – IF DECEASED GIVE DATE OF DEATH
	A												
	B												
	C												
	D												
	E												
	F												
	G												

SIGNATURE	OFFICER'S RANK AND NAME	BADGE NO.	DEPARTMENT	PRECINCT/POST TROOP/ZONE	STATION/BEAT/SECTOR	REVIEWING OFFICER	DATE/TIME REVIEWED

ZS-6117-V-1

MV-104A (9/75) **Cover Sheet — POLICE ACCIDENT REPORT** (to be used with the MV-104A and MV-104AN)

Place this sheet over the front of the accident report so that the numbered arrows line up with the boxes of the same number along the edges of the report. This will explain the meaning of the numbers written in the boxes.

(1) PEDESTRIAN LOCATION
1. Pedestrian at Intersection
2. Pedestrian Not at Intersection

(2) PEDESTRIAN ACTION
1. Crossing, With Signal
2. Crossing, Against Signal
3. Crossing, No Signal, Marked Crosswalk
4. Crossing, No Signal or Crosswalk
5. Walking Along Highway With Traffic
6. Walking Along Highway Against Traffic
7. Emerging from in Front of/Behind Parked Vehicle
8. Going To/From Stopped School Bus
9. Getting On/Off Vehicle Other Than School Bus
10. Pushing/Working On Car
11. Working in Roadway
12. Playing in Roadway
13. Other Actions in Roadway *
14. Not in Roadway (Indicate) *

(3) TRAFFIC CONTROL
1. None
2. Traffic Signal
3. Stop Sign
4. Flashing Light
5. Yield Sign
6. Officer/Flagman/Guard
7. No Passing Zone
8. RR Crossing Sign
9. RR Crossing Flashing Lt.
10. RR Crossing Gates
11. Stopped School Bus - Red Lights Flashing
20. Other *

APPARENT CONTRIBUTING FACTORS

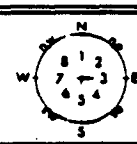
HUMAN
2. Alcohol Involvement
3. Backing Unsafely
4. Driver Inattention (Indicate) *
5. Driver Inexperience (Indicate) *
6. Drugs (Illegal)
7. Failure to Yield Right-of-Way
8. Fell Asleep
9. Following Too Closely
10. Illness
11. Lost Consciousness
12. Passenger Distraction
13. Passing or Lane Usage Improper
14. Pedestrian's Error/Confusion
15. Physical Disability
16. Prescription Medication
17. Traffic Control Disregarded
18. Turning Improperly
19. Unsafe Speed
40. Other Human *

VEHICULAR
41. Accelerator Defective
42. Brakes Defective
43. Headlights Defective
44. Other Lighting Defects
45. Oversized Vehicle
46. Steering Failure
47. Tire Failure/Inadequate
48. Tow Hitch Defective
49. Windshield Inadequate
60. Other Vehicular *

ENVIRONMENTAL
61. Animal's Action
62. Glare
63. Lane Marking Improper/Inadequate
64. Obstruction/Debris
65. Pavement Defective
66. Pavement Slippery
67. Shoulders Defective/Improper
68. Traffic Control Device Improper/Non-Working
69. View Obstructed/Limited
80. Other Environmental *

Vehicle 1 (19) — Vehicle 1 (20) — Vehicle 2 (21) — Vehicle 2 (22)

DIRECTION OF TRAVEL



Vehicle 1 (23) — Vehicle 2 (24)

(4) LIGHT CONDITIONS
1. Daylight
2. Dawn
3. Dusk
4. Dark-Road Lighted
5. Dark-Road Unlighted

State of New York
Department of Motor Vehicles

POLICE ACCIDENT REPORT

MV-104A (9/75)

* EXPLAIN IN ACCIDENT DESCRIPTION

IF A QUESTION DOES NOT APPLY, ENTER A DASH (—).

IF AN ANSWER IS UNKNOWN, ENTER AN "X"

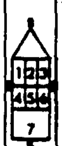
(5) ROADWAY CHARACTER
1. Straight and Level
2. Straight and Grade
3. Straight at Hillcrest
4. Curve and Level
5. Curve and Grade
6. Curve at Hillcrest

(6) ROADWAY SURFACE CONDITION
1. Dry
2. Wet
3. Muddy
4. Snow/Ice
5. Slush
10. Other *

(7) WEATHER
1. Clear
2. Cloudy
3. Rain
4. Snow
5. Sleet/Hail/Freezing Rain
6. Fog/Smog/Smoke
10. Other *

(8) WHICH VEHICLE OCCUPIED
1. Vehicle No. 1
2. Vehicle No. 2
B. Bicyclist
P. Pedestrian
O. Other *

(9) POSITION IN/ON VEHICLE
1. Driver
2–7. Passengers
8. Riding/Hanging On Outside



(10) SAFETY EQUIPMENT USED
1. No Restraint Used
2. Lap Belt
3. Harness
4. Lap Belt and Harness
5. Child Restraint
10. Other *

(11) EJECTION FROM VEHICLE
1. Not Ejected
2. Partially Ejected
3. Ejected

(12) AGE

(13) SEX

(14) LOCATION OF MOST SEVERE PHYSICAL COMPLAINT
1. Head
2. Face
3. Eye
4. Neck
5. Chest
6. Back
7. Shoulder-Upper Arm
8. Elbow-Lower Arm-Hand
9. Abdomen - Pelvis
10. Hip-Upper Leg
11. Knee-Lower Leg-Foot
12. Entire Body

(15) TYPE OF PHYSICAL COMPLAINT
1. Amputation
2. Concussion
3. Internal
4. Minor Bleeding
5. Severe Bleeding
6. Minor Burn
7. Moderate Burn
8. Severe Burn
9. Fracture - Dislocation
10. Contusion - Bruise
11. Abrasion
12. Complaint of Pain
13. None Visible

(16) VICTIM'S PHYSICAL AND EMOTIONAL STATUS
1. Apparent Death
2. Unconscious
3. Semiconscious
4. Incoherent
5. Shock
6. Conscious

INJURED TAKEN
17 BY | TO 18

PRE-ACCIDENT VEHICLE ACTION
1. Going Straight Ahead
2. Making Right Turn
3. Making Left Turn
4. Making U Turn
5. Starting from Parking
6. Starting in Traffic
7. Slowing or Stopping
8. Stopped in Traffic
9. Entering Parked Position
10. Parked
11. Avoiding Object in Roadway
12. Changing Lanes
13. Overtaking
14. Merging
15. Backing
20. Other *

Vehicle 1 (25) — Vehicle 2 (26)

(27) LOCATION OF FIRST EVENT
1. On Roadway
2. Off Roadway

TYPE OF ACCIDENT

COLLISION WITH
1. Other Motor Vehicle
2. Pedestrian
3. Bicyclist
4. Animal
5. Railroad Train
10. Other Object (Not Fixed) *

COLLISION WITH FIXED OBJECT
11. Light Support/Utility Pole
12. Guide Rail
13. Crash Cushion
14. Sign Post
15. Tree
16. Building/Wall
17. Curbing
18. Fence
19. Bridge Structure
20. Culvert/Head Wall
21. Median/Barrier
22. Snow Embankment
23. Earth Embankment/Rock Cut/Ditch
24. Fire Hydrant
30. Other Fixed Object *

NON-COLLISION
31. Overturned
32. Fire/Explosion
33. Submersion
34. Ran Off Roadway Only
40. Other *

First Event (28)

SECOND EVENT: Vehicle 1 (29) — Vehicle 2 (30)

COVER SHEET **B**

TEAM	YEAR	MONTH	DAY	SEQUENCE
__	__	__ __	__ __	__ __ __

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

VEHICLE DATA

Vehicle Data Collected? Yes ☐ No ☐

If not collected - Reason? ______________________________

____

__ Update Number

__ Vehicle No.

__ __ No. of VIN Characters

__ __ __ __ __ __ __ VIN

(Left Justify, Omit Production Numbers)

__________ Make/Model

__ __ __ __ __ CPIR Code

__________ Color

__ __ __ __ __ Mileage

99998 = 99998 Mi.+ 99999 = Unknown

__ __ Model Year

BODY STYLE:

01 Passenger Car
02 Stationwagon
03 Convertible
04 Car, Pickup Body (e.g., El Camino, Ranchero, etc.)
05 Van-Passenger
06 Van-Cargo
07 Pickup
98 Other Body Style __________
99 Unknown

VEHICLE WEIGHT:

__ __ __ 0 0 Curb

__ __ __ 0 0 Occupant and Cargo

__ __ __ 0 0 Total

TOWING ANOTHER VEHICLE:

1. Yes
2. No
9. Unknown

SOURCE OF VEHICLE DATA:

1. Inspection at Repair or Tow Facility
2. Inspection at Person's Home
3. Inspection at Scene
4. Investigation at Scene and 1, 2 or 5
5. Inspected Elsewhere __________
6. Not Inspected (Photos or Repair Data)
7. Not Inspected. Reason __________
9. Unknown

NOTES: (Describe relevant exterior modifications and the condition of visibility items such as headlights, windshield, side windows, mirrors, etc.; sketch and dimension modifications on appropriate damage and contact sheet.) __________

9/77 Form 001 1

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

VEHICLE DATA

VEHICLE DAMAGE: (Complete Vehicle Sketch Prior to Completing this Page)

Total Damage

	Object Contacted	CDC**			Impact No.***
1.*	__ __	__ __	__ __ __ __	__	__
2.	__ __	__ __	__ __ __ __	__	__
3.	__ __	__ __	__ __ __ __	__	__

* 1. = Highest Severity (Estimated ΔV)
** Generally one CDC for a Pedestrian Impact
*** Accident Viewpoint

Object Contacted

01 Passenger Car
02 Light Truck (to 10,000 GVW)
03 Truck (over 10,000 GVW)
04 Bus
05 Bicycle
06 Motorcycle
07 Other Vehicle ________
11 Pedestrian
12 Large Animal
13 Tree
14 Pole
15 Other Fixed Object
16 Other Movable Obj.
17 Other ________
99 Unknown ________

Pedestrian Related Damage (Vehicle damage from contact with Ped. # ____)

	Wrap Dist.	Component Location	Component** Contacted	Striking Profile	Type of Damage	Extent of Damage	Contact*** No.
1.*	_ _ _	__	__ __ __	__	__	__	__
2.	_ _ _	__	__ __ __	__	__	__	__
3.	_ _ _	__	__ __ __	__	__	__	__
4.	_ _ _	__	__ __ __	__	__	__	__
5.	_ _ _	__	__ __ __	__	__	__	__
6.	_ _ _	__	__ __ __	__	__	__	__

* 1. = Most Damage to Vehicle
** Use Codes Listed on Pages 3 and 4 of this Form
*** Chronological Sequence of Occurrence

Component Location
1. Front
2. Left Side
3. Right Side
4. Rear
5. Top
6. Undercarriage
8. Not Applicable
9. Unknown

Striking Profile
1. Flat, Narrow (<6")
2. Flat, Wide (>6")
3. Rounded (Contoured)
4. Rounded Edge
5. Sharp Edge
7. Other ________
8. Not Applicable
9. Unknown

Type of Damage
0. No Evidence of Contact
1. No Damage (Tissue or cloth transfer, scuff mark, etc.)
2. Scratch
3. Local Dent (<6" Diameter)
4. Large Deformation (>6" Diameter)
5. Cracked, Fractured, Shattered
6. Separated from Veh.
7. Other ________
8. Not Applicable
9. Unknown

Extent of Damage
0. No Residual Damage
1. Surface Damage
Crush Damage:
2. (>0" to 1/2")
3. (>1/2" to 2")
4. (>2" to 4")
5. (>4")
6. Non-Crush Damage (Fractured, Cracked, etc.)
7. Other ________
8. Not Applicable
9. Unknown

Vehicle Measurements:

01-97	Actual height in inches
98	Not Applicable
99	Unknown

Vehicle #1

Bumper Height	_ _
Contact Height	_ _
Hood Height	_ _
Bumper Lead	_ _
Hood Length	_ _
Side Protrusion	_ _
Beltline	_ _
Rear Bumper Height	_ _
Trunk Height	_ _

Vehicle #2 (if applicable)

Bumper Height	_ _
Contact Height	_ _
Hood Height	_ _
Bumper Lead	_ _
Hood Length	_ _
Side Protrusion	_ _
Beltline	_ _
Rear Bumper Height	_ _
Trunk Height	_ _

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY
COMPONENTS CONTACTED/DAMAGED BY PEDESTRIAN

	Contacted	Damaged Yes	Damaged No	Damaged Unk.
Front Bumper				
Face	001	1	2	9
Top	002	1	2	9
Bottom	003	1	2	9
Bumper Guard and/or Rubber Moldings	004	1	2	9
Bumper Bolt	005	1	2	9
Filler Panel	006	1	2	9
Valance (splash panel)	007	1	2	9
Front License Plate Assembly				
Bracket	020	1	2	9
Plate	021	1	2	9
Bracket and Plate	022	1	2	9
Grille				
Grille	030	1	2	9
Grille Edge - horizontal	031	1	2	9
- vertical	032	1	2	9
Trim (molding) - Be sure to distinguish between edge of hood and trim.)	033	1	2	9
Insect Screen	034	1	2	9
Headlight				
Door - Open	040	1	2	9
Door - Closed	041	1	2	9
No Door Covering - (head lamps exposed)	042	1	2	9
Trim - Mounting Plate	043	1	2	9
Parking Lights	044	1	2	9
Hood				
Hood - Face	050	1	2	9
Hood - Top	051	1	2	9
Cowl - Plain	052	1	2	9
Cowl - Wiper Blade Mount	053	1	2	9
Fender (front)				
Fender	060	1	2	9
Inner Panel	061	1	2	9
Fender-horizontal edge	062			
-vertical edge	063	1	2	9
Radio Antenna (rigid base)	064	1	2	9
Radio Antenna flexible base)	065	1	2	9
Windshield				
Glass Only	100	1	2	9
Trim Only	101	1	2	9
Glass & Trim-top	102	1	2	9
-bottom	103	1	2	9
-A-pillar	104	1	2	9
Wiper or Mount	105	1	2	9

	Contacted	Damaged Yes	Damaged No	Damaged Unk.
Top & Upper Side Area				
Roof	110	1	2	9
A-Pillar	111	1	2	9
B-Pillar	112	1	2	9
C-Pillar	113	1	2	9
D-Pillar	114	1	2	9
Side Rail	115	1	2	9
Door & Lower Side Area				
Door Surface	120	1	2	9
Door Handle	121	1	2	9
External Door Hinges	122	1	2	9
Door Ajar (interior door structure	123	1	2	9
Rocker Panel	124	1	2	9
Windows				
Front Vent	130	1	2	9
Side Window-Front	131	1	2	9
Side Window-Rear	132	1	2	9
Rear Vent, Quarter, or Opera Window	133	1	2	9
Backlight	134	1	2	9
Rear Fender or Quarter Panel				
Fender or Quarter Panel	300	1	2	9
Inner Fender Panels	301	1	2	9
Fender-horizontal edge	302	1	2	9
-vertical edge	303	1	2	9
Radio Antenna (rigid base)	304	1	2	9
Radio Antenna (flexible base)	305	1	2	9
Tail Gate or Trunk Deck Lid - Open	310	1	2	9
Tail Gate or Trunk Deck Lid - Closed	311	1	2	9
Tail Lights	312	1	2	9
Back-up Lights	313	1	2	9
Rear Bumper				
Face	320	1	2	9
Top	321	1	2	9
Bottom	323	1	2	9
Bumper Guard and/or Rubber Moldings	324	1	2	9
Bumper Bolt	325	1	2	9
Filler Panel	326	1	2	9
Valance (splash panel)	327	1	2	9
Rear License Plate Assembly				
Bracket	330	1	2	9
Plate	331	1	2	9
Bracket and Plate	332	1	2	9

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY
COMPONENTS CONTACTED/DAMAGED BY PEDESTRIANS

	Contacted	Damaged Yes	Damaged No	Damaged Unk.
Tires				
Standard (including snow tread)	400	1	2	9
Studded or Chains	401	1	2	9
Wheels				
Without Covers	410	1	2	9
With Standard Covers	411	1	2	9
With Custom Covers (wire, spinners, mags, etc.)	412	1	2	9
Undercarriage				
Tie Rod Assembly	420	1	2	9
Steering Knuckle	421	1	2	9
A Arm Assembly	422	1	2	9
Oil Pan	423	1	2	9
Bell Housing	424	1	2	9
Crossmembers	425	1	2	9
Rear Axle Housing	426	1	2	9
Front Lower A Frames	427	1	2	9
Front Stabilizing Struts	428	1	2	9
Transmission	429	1	2	9
Front Shock Absorbers	430	1	2	9
Front Springs	431	1	2	9
Rear Suspension Arms	432	1	2	9
Rear Springs (leaf or coil)	433	1	2	9
Undercarriage Unknown	440	1	2	9
Exhaust System				
Header(s) (or exhaust pipe)	450	1	2	9
Muffler(s)	451	1	2	9
Tail Pipe(s)	452	1	2	9
Resonator	453	1	2	9
Drive Shaft				
Universal Joint Assembly	460	1	2	9
Shaft	461	1	2	9
Floor Pan	470	1	2	9
Fuel Tank Area				
Tank	480	1	2	9
Straps	481	1	2	9
Supports	482	1	2	9
Energy Transmittal	500	1	2	9
Accessories or Ornamentation				
Air Scoops	600	1	2	9
Curb Feelers	601	1	2	9
Emergency Lights	602	1	2	9
Fender Flare or Extension	603	1	2	9
Fog Lights	604	1	2	9
Fuel Tank Filler Cap	605	1	2	9
Hood Latches, Knobs, or Handles	606	1	2	9

	Contacted	Damaged Yes	Damaged No	Damaged Unk.
Accessories or Ornamentation (CONTINUED)				
Hood Ornament, fixed	607	1	2	9
Hood Ornament, spring loaded	608	1	2	9
Horn	609	1	2	9
Letters, Numerals or Other Ornaments on Sheet Metal Surface	610	1	2	9
Luggage or Ski Rack	611	1	2	9
Material Protruding from Windows	612	1	2	9
Material Tied on Side	613	1	2	9
Material Tied on Top	614	1	2	9
Plate (insignia)	615	1	2	9
Rear Exhaust Pipe or Extension	616	1	2	9
Side Exhaust Pipe	617	1	2	9
Side Mounted Rear View Mirror	618	1	2	9
Sign or Advertisement	619	1	2	9
Spare Tire	620	1	2	9
Spot Light	621	1	2	9
Tow Bar, Trailer Hitch	622	1	2	9
Trim or Molding	623	1	2	9
Other Vehicle	700	1	2	9
Other Pedestrian	701	1	2	9
Environmental Surface				
Sidewalk	800	1	2	9
Pavement	801	1	2	9
Shoulder	802	1	2	9
Ground Beyond Shoulder	803	1	2	9
Raised Median or Curb	804	1	2	9
Sign or Sign Support	805	1	2	9
Other Veh. (en Route to ground)	806	1	2	9
Other Veh. (final position)	807	1	2	9
Debris	808	1	2	9
Tree	809	1	2	9
Bush, Shrub, etc.	810	1	2	9
Environmental Surface Unknown	819	1	2	9
Underhood Components				
Air Cleaner	901	1	2	9
Other (specify _______)	909	1	2	9
Non-Contact Injury Source	950	1	2	9
Unknown	999	1	2	9

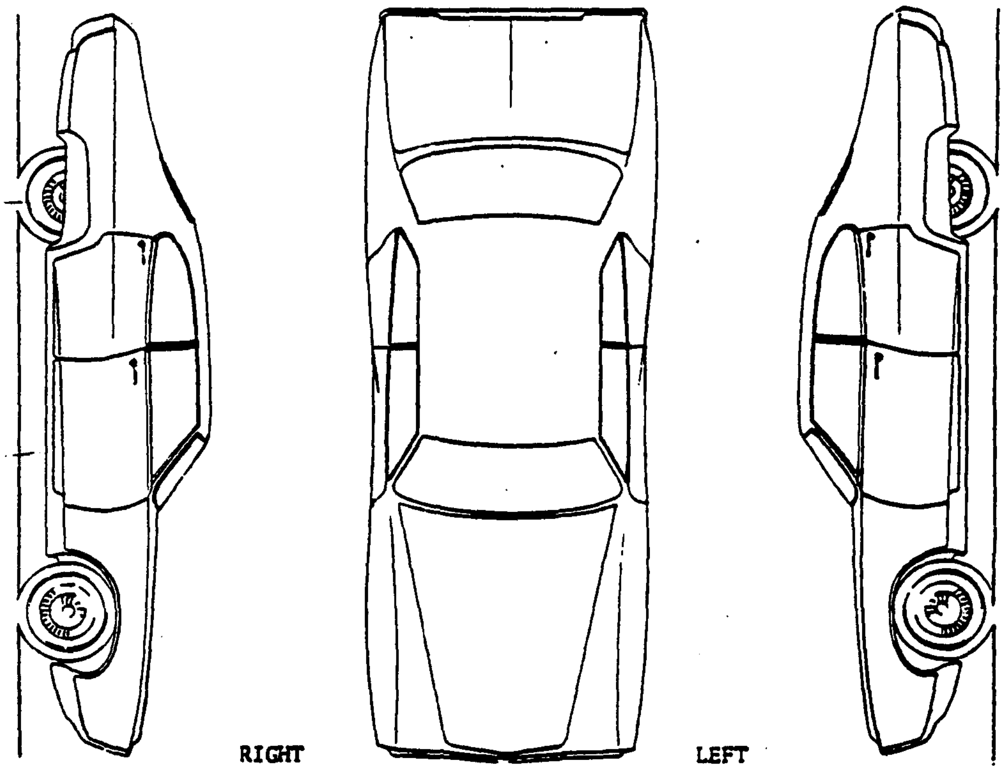
9/77 Form 001

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY
ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

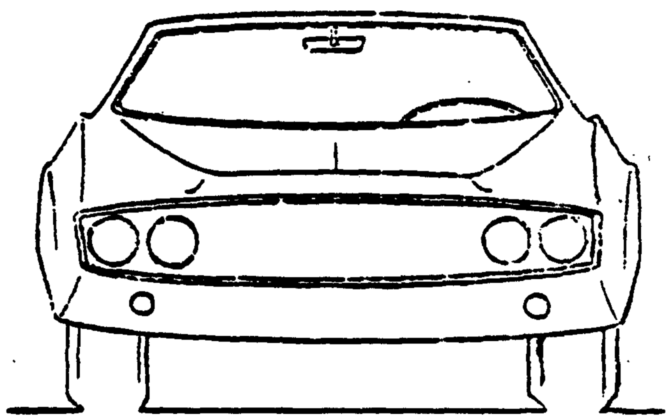
VEHICLE DAMAGE AND PEDESTRIAN CONTACTS - CAR

FRONT IMPACT



NOTE: Measure all damage and pedestrian contacts from the ground and from left to right side or rear to front of car, as appropriate.

Please number all pedestrian contacts in the sequence that they occur.



Wheelbase ________

Track Width ________
(Original Dimensions)

Provide the following base measures at the area of impact:

Ground to Top of Bumper _____ Ground to Hood Edge or Edge of Upper Grill Panel _____

9/77 Form 001-A

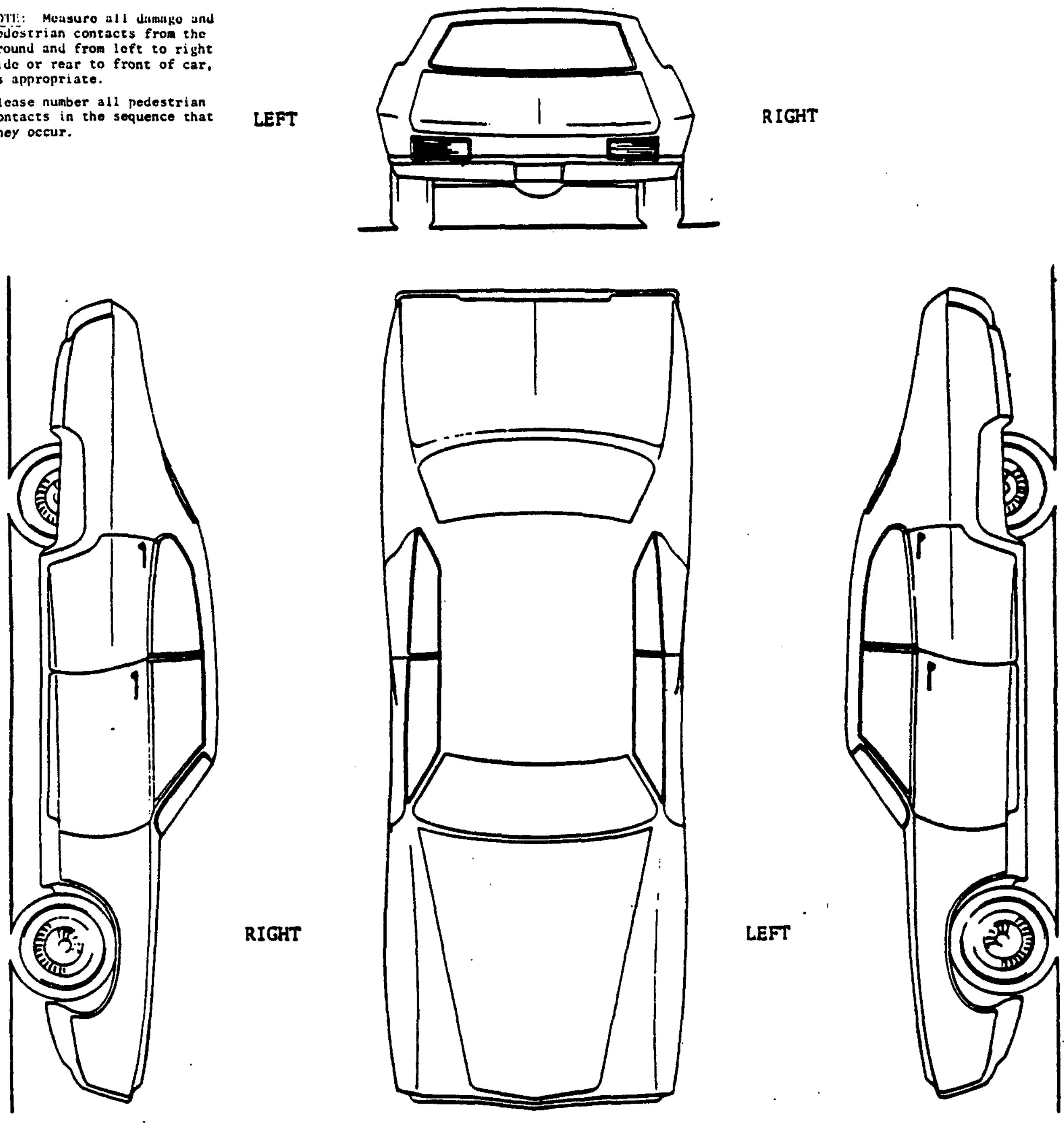
5

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY
VEHICLE DAMAGE AND PEDESTRIAN CONTACTS - CAR
SIDE OR REAR IMPACT

NOTE: Measure all damage and pedestrian contacts from the ground and from left to right side or rear to front of car, as appropriate.

Please number all pedestrian contacts in the sequence that they occur.



Provide the following base measures at the area of impact:

Side Impact:
- Ground to maximum side protrusion ____
- Ground to belt line ____

Rear Impact:
- Ground to top of rear bumper ____
- Ground to trunk edge ____

Wheelbase ______________

Track Width ______________
(Original Dimensions)

9/77 Form 001-B

5

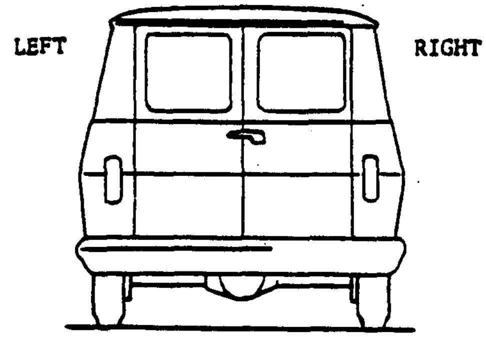
DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY
VEHICLE DAMAGE AND PEDESTRIAN CONTACT REPORT FORM - VAN

ALL IMPACT AREAS

NOTE: Measure all damage and pedestrian contacts from the ground and from left to right side or rear to front of car, as appropriate.

Please number all pedestrian contacts in the sequence that they occur.

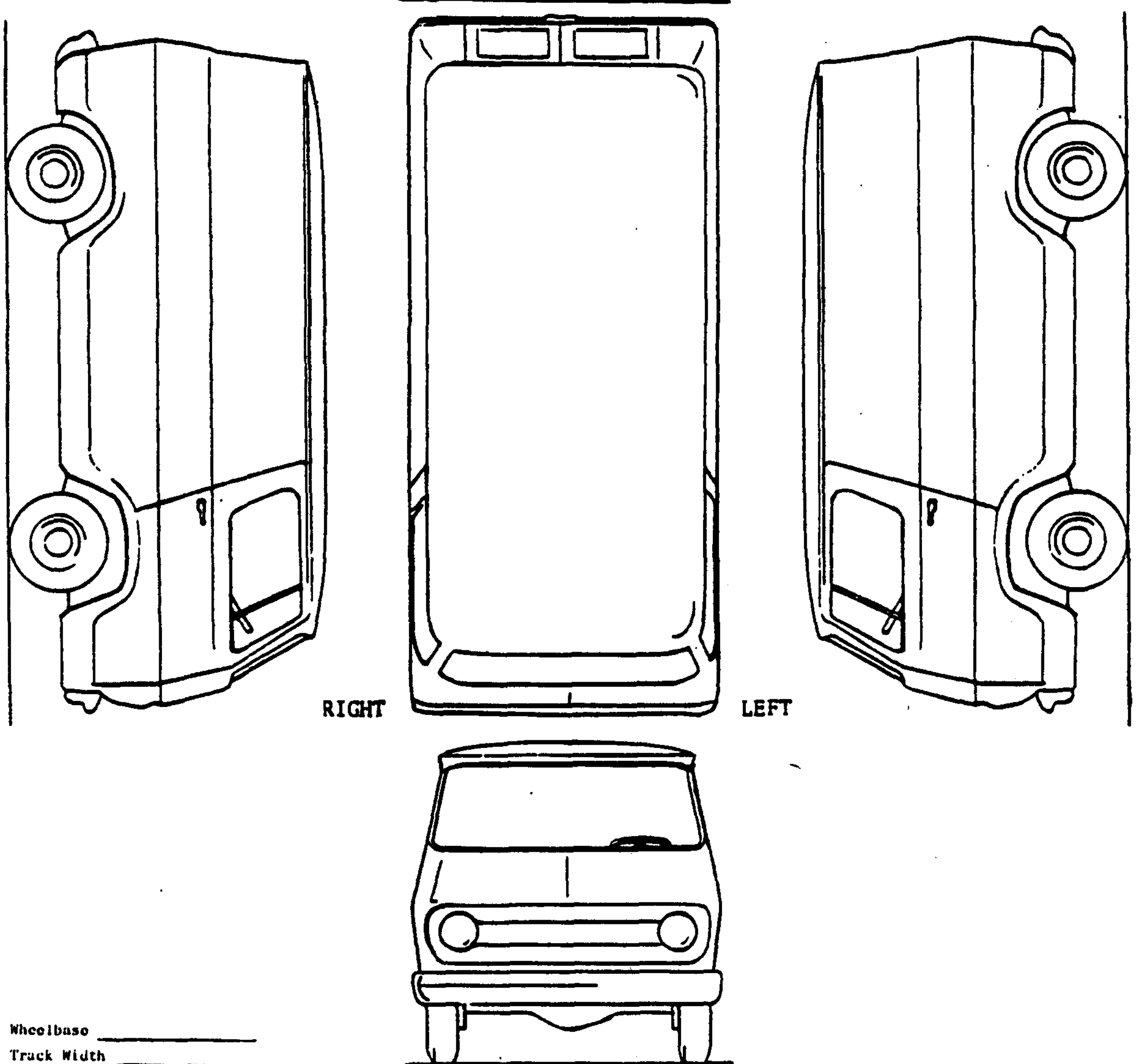


Provide the following base measures at the area of impact:

Front Impact:
- Ground to top of bumper ____
- Ground to hood edge or edge of upper grill panel ____

Side Impact:
- Ground to maximum side protrusion ____
- Ground to belt line ____

Rear Impact:
- Ground to top of bumper ____
- Ground to belt line ____



Wheelbase ________

Track Width ________
(Original Dimensions)

9/77 Form 001-C

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY
ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

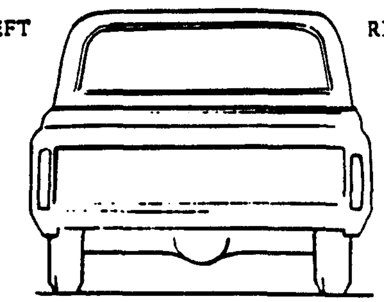
VEHICLE DAMAGE AND PEDESTRIAN CONTACT REPORT FORM - PICK-UP TRUCK

ALL IMPACT AREAS

NOTE: Measure all damage and pedestrian contacts from the ground and from left to right side or rear to front of car, as appropriate.

Please number all pedestrian contacts in the sequence that they occur.

LEFT



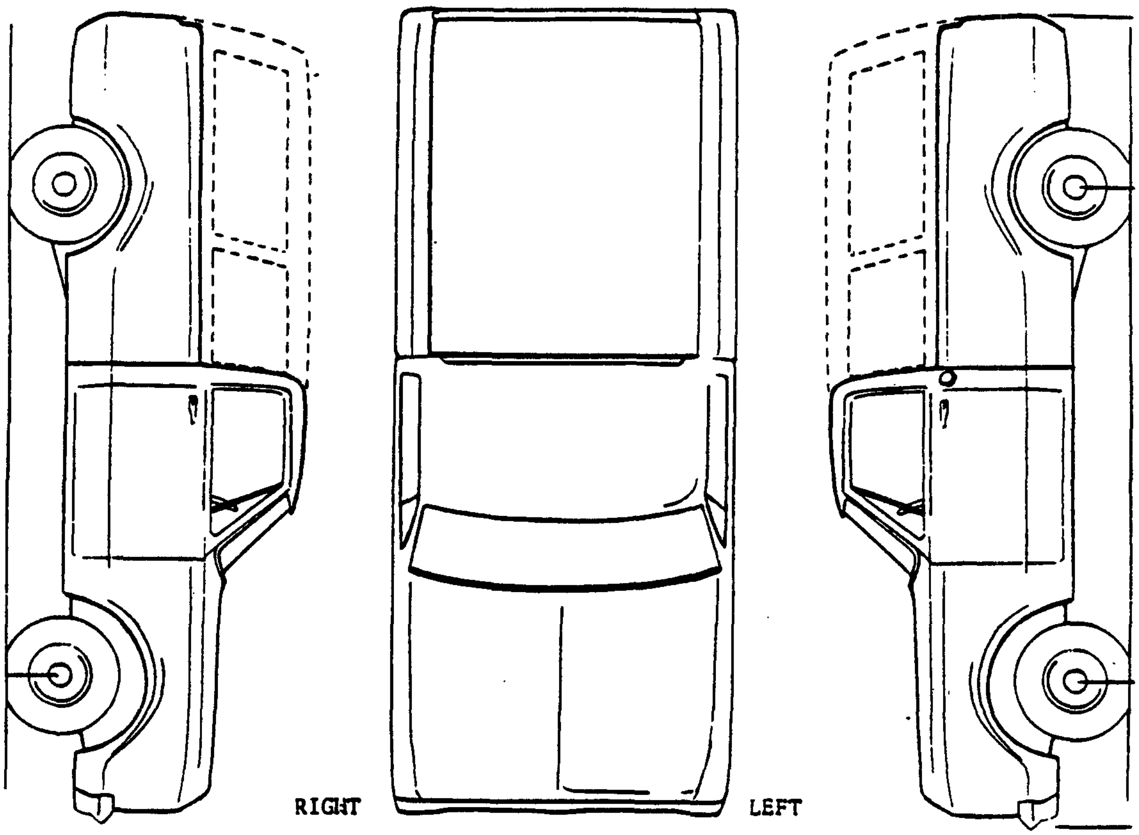
RIGHT

Provide the following base measures at the area of impact:

Front Impact.
- Ground to top of bumper ____
- Ground to hood edge or edge of upper grill panel ____

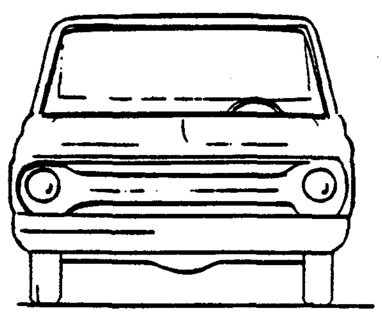
Side Impact:
- Ground to maximum side protrusion ____
- Ground to belt line ____

Rear Impact:
- Ground to top of bumper ____
- Ground to belt line or top of body line ____



RIGHT

LEFT



Wheelbase ____________

Track Width ____________
(Original Dimensions)

9/77 **Form 001-D**

TEAM	YEAR	MONTH	DAY	SEQUENCE
__	__	__ __	__ __	__ __ __

E

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY
ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

ENVIRONMENTAL - SCENE DATA ELEMENTS

Environmental Data Collected? Yes ☐ No ☐

If not collected - Reason? ______________________________

____

__ Update Number

ACCIDENT LOCATION:

Area
1. Rural
2. Urban
3. Unknown

Zone
1. Residential
2. Apartments
3. School or Playground
4. Commercial
5. Other
9. Unknown

Intersection
0. None
1. 3 Leg T
2. 3 Leg Y
3. 4 Leg Cross
4. 4 Leg Oblique
5. Multileg
9. Unknown

Traffic Control
0. None
1. Signs
2. Signals
3. Pedestrian Signals
4. Marked Crosswalk
5. Crossing Guard
6. 2 and 4
7. 3 and 4
8. Other ________
9. Unknown

Light Condition
1. Daylight
2. Dawn or Dusk
3. Darkness
9. Unknown

Lighting (artificial)
0. None
1. Daylight (NA)
2. Lighted
9. Unknown

FUNCTIONAL CLASSIFICATION OF SITE:

Principal Arterials
01. Arterial Highway
02. Expressway
03. Freeway
04. Major Arterials - Major St./Highway
05. Collector - Through St./Highway
06. Local St./Road
07. Other Hwy. ______
12. Driveway
17. Other ________
98. Not Applicable
99. Unknown

No. of Lanes __ __

Accident Occurred in:
1. Lane No. ___
22. Shoulder
23. Sidewalk
24. Driveway
97. Other ______
98. NA
99. Unk.

POSTED SPEED LIMIT:

__ __ MPH

98. Not Applicable
99. Unknown

ALIGNMENT: (ALONG VEHICLE TRAVEL DIRECTION)

Horizontal
1. Straight
2. Curve Right
3. Curve Left
8. Not Applicable
9. Unknown

Vertical
1. Level
2. Uphill
3. Downhill
4. Crest of Hill
5. Bottom of Hill
8. Not Applicable
9. Unknown

SURFACE TYPE:
1. Portland Cement Concrete
2. Bituminous Concrete
3. Brick, Block
4. Slag, Stone, Shell, Gravel
5. Other (Specify) ____________
6. Dirt
8. Not Applicable
9. Unknown

SURFACE CONDITION:

1. New
2. Traveled
3. Travel Polished
4. Worn
5. Other ______
8. Not Applicable
9. Unknown

1. Dry
2. Wet
3. Snow
4. Ice
5. Other ______
8. Not Applicable
9. Unknown

WEATHER:
1. Clear/Dry
2. Rain
3. Snow
4. Fog
5. Cloudy/Overcast
9. Unknown

EDGE TYPE:
0. No Curb or Shoulder
1. Curb, No Shoulder
2. Shoulder, No Curb
3. Shoulder & Curb
4. No curb, sidewalk
5. Curb, sidewalk
7. Other ______
8. Not Applicable
9. Unknown

COEFFICIENT OF FRICTION
(List in Sequence Traversed by Vehicle)
Source of Information ____________

. __ __ Surface ____________
. __ __ Surface ____________
. __ __ Surface ____________

98. Not Applicable
99. Unknown

9/77 Form 002

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY
ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

ENVIRONMENTAL - SCENE DATA ELEMENTS

VEHICLE ACTIVITY PRIOR TO ACCIDENT SEQUENCE:

Driver Controlled	Not Driver Controlled
01 Going Straight	21 Sliding, Leading with Front
02 Right Turn	22 Sliding, Leading with Right
03 Left Turn	23 Sliding, Leading with Left
04 U-Turn	24 Sliding, Leading with Rear
05 Changing Lanes	25 Rotating: Clockwise
06 Passing	26 Rotating: Counterclockwise
07 Backing	97 Other
08 Parking	98 Not Applicable
09 Leaving Parked Position	99 Unknown
10 Starting in Roadway	

ATTEMPTED AVOIDANCE MANEUVER:

00 None
01 Braking
02 Steering Left
03 Steering Right
04 Braking and Steering Left
05 Braking and Steering Right
06 Accelerating
07 Accel. and Steering Left
08 Accel. and Steering Right
09 Brake Release
10 Other ______
98 Not Applicable
99 Unknown

Velocity Data

01 Slowing
02 Accelerating
03 Traveling at Constant Velocity
04 None: Stopped in Traffic
05 None: Double Parked
06 None: Parked, Not in Traffic
99 Unknown

VEHICLE ORIENTATION AT IMPACT:

1. Tracking, No Skidding
2. Tracking, Skidding
3. Rotated Clockwise to Path of Travel
4. Rotated Counterclockwise to Path of Travel
5. Rolling Over
6. Other ______
8. Not Applicable
9. Unknown

CHECKLIST OF DATA ELEMENTS TO BE DIAGRAMMED

Point of Impact (POI) for each impact involving vehicles, pedestrians, and objects as defined by cg position and heading angle for veh. Scuff marks or other evidence is used to define ped. location.

Final Rest Position (FRP) of veh. and of the ped.

Point on all trajectories which are curved paths between POI and FRP.

Tire Marks
a) length of RF, LF, RR, and LR during pre-crash and crash phases
b) spacing between tire marks for veh. in rotational skid patterns - if rotation ceases prior to FRP, specify location with veh. cg position and heading angle.

Nontire Marks
Scratching, abrading, gouging, blood or cloth transfers, etc.

Location of coefficient of friction boundaries.

Location and nature of objects struck including damage descriptions.

Debris distribution pattern.

Pedestrian Trajectory.

Pedestrian Throw Distance (if applicable).

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY
ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY
ENVIRONMENTAL - SCENE MEASUREMENT LOG

(Using grid coordinate system, locate evidence and terrain features of interest.)

REFERENCE POINT (RP) - SPECIFY - ______________________________

REFERENCE LINE (RL) - SPECIFY - ______________________________

Item	Dist. and Dir. from RP	Dist. and Dir. from RL

9/77 Form 002

A

TEAM	YEAR	MONTH	DAY	SEQUENCE
_	_	_ _	_ _	_ _ _

PEDESTRIAN INJURY CAUSATION STUDY

ADMINISTRATIVE DATA

ADMINISTRATIVE DATA

Update Number ___

City and County ___ ___ ___

Police Jurisdiction ___ ___

Day of Week ___

Time of Accident (24 hour clock time) ___ ___ ___ ___

Source of Notification ___________

Date of Investigation (Month, Day - e.g., May 1 = 05/01) ___/___

Type of Investigation: 1 On Scene, 2 Follow-On, 3 Both ___

Team Response Time (For on-scene investigations) ___ ___

Investigator(s) [Initials] ___________

Accident Type ___

No. of Vehicles Involved ___

No. of Pedestrians Involved ___

Were Vehicles and Peds. Observed at Scene? 1 Yes, 2 No

Veh. #1 ___ #2 ___

Ped. #1 ___ #2 ___ #3 ___

Police Reported Alcohol Involvement? 1 Yes, 2 No, 8 NA, 9 Unk. ___

BAC (mg %) Reported? 2 No, 8 NA, 9 Unk.

Dr. #1 ___ #2 ___ } RECORD BAC

Ped. #1 ___ #2 ___ #3 ___ }

Type of BAC:

1. BAC Not Reported 3. Blood Test 8. NA
2. Breath Test 4. Type Unknown 9. Unk.

Dr. #1 ___ #2 ___

Ped. #1 ___ #2 ___ #3 ___

Highest Overall AIS (for Pedestrians Only): ___

Highest ISS (for Pedestrians Only): ___

Travel Speeds (Computed Speeds Only) Veh. #1 ___

00 Stopped, 01-96 Actual Speed, 97 97 or More, 98 NA, 99 Unk. Veh. #2 ___

Impact Speeds (Computed Speeds Only) Veh. #1 ___

00 Stopped, 01-96 Actual Speed, 97 97 or More, 98 NA, 99 Unk. Veh. #2 ___

Fatals Involved? 1 Yes 2 No 9 Unk. ___

Fatals ___

9/77 Form 004

1

H1

TEAM	YEAR	MONTH	DAY	SEQUENCE
___	___	___ ___	___ ___	___ ___ ___

DEPARTMENT OF TRANSPORTATION NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

HUMAN: MEDICAL DATA SUPPLEMENT

PEDESTRIAN NUMBER ___

Complete this form for each injured pedestrian and attach a copy of the medical report.

PEDESTRIAN PATIENT HISTORY

Outpatient Visits ___ ___
- 0 None
- 1-6 Actual Number → (Record Number)
- 7 7 or More
- 8 Not Applicable
- 9 Unknown

Activity Restriction*
- Bed Rest ___ ___ ___
- Other Restriction (Describe ___ ___ ___ ___
- Work Days Lost ___ ___ ___
- Days in Hospital ___ ___ ___

*See Manual for codes used & check corresponding data on Pg. 10, Human Data Form

Long Term Disabilities ___ ___
- 0. None Sustained
- 9. Unknown
- 1. Disability Sustained

Describe ______________________

DATA SOURCE (Code Data Source Beside Specific Codes on Left)
1. Hospital Record
2. Pedestrian*
3. Treating Physician
4. Other ___________
5. Pedestrian + Hospital Record
6. Pedestrian + Treating Physician
7. Pedestrian + Other ___________
8. Hospital Record + Other ___________
9. Treating Physician + Other ___________

*Pedestrian or Other Family Member

INJURY DESCRIPTION

More than Ten Injuries Sustained ___
1. Yes 2. No 9. Unknown

If more than ten injuries were sustained, describe the ten severest injuries.

Inj. No.	Contact No.	Body Region	Aspect	Lesion	System/ Organ	AIS Severity	Injury Source	ICDA	Overall AIS
1	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	___
2	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	
3	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	
4	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	
5	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	
6	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	
7	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	ISS Score
	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	
9	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	___
10	___	___	___	___	___	___	___ ___ ___	___ ___ ___.___	

9/77 Form 005

1

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

MEDICAL DATA

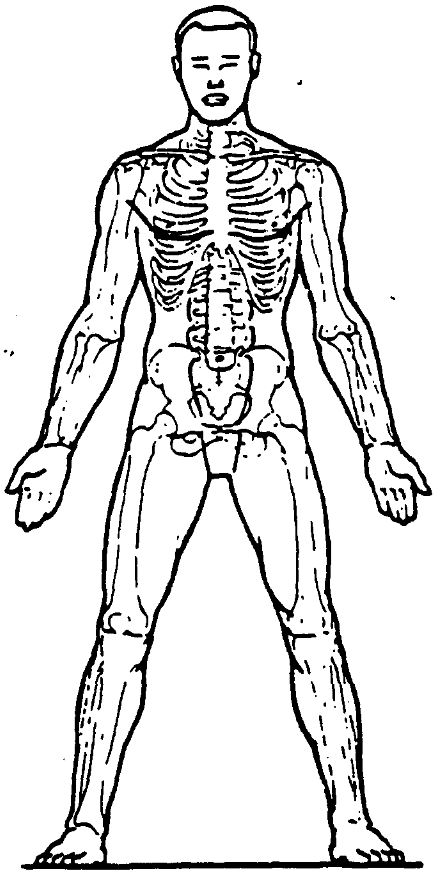
GRAPHICALLY INDICATE LOCATION AND TYPE OF INJURIES

PLEASE INCLUDE ALL INJURIES, NO MATTER HOW MINOR,* WHETHER PATIENT LIVED OR DIED

APPROXIMATE AGE:
WEIGHT:
HEIGHT:

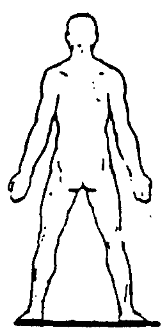
NOTE:
The pattern of minor soft tissue injuries, especially those overlying fractures or internal injuries, are particularly important in determining injury mechanism. Also, please describe any foreign material found in wounds, i.e., glass, gravel, tar, etc.

RIGHT



LEFT

LEFT



REAR

RIGHT

*IMPORTANT: To distinguish between injuries caused by vehicle structures and secondary impacts with pavement please indicate location and describe injury; brush burns, abrasions, lacerations, fractures, etc.

9/77 Form 005

2

H

TEAM	YEAR	MONTH	DAY	SEQUENCE
__	__	__ __	__ __	__ __ __

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

HUMAN DATA

Human data collected? Yes ☐ No ☐

If not collected - Reason? ______________________________

____

ADMINISTRATIVE DATA

Update Number ____

Date of Accident (Month, Day, Year) ____________

Date Investigation Began (Month, Day, Year) ____________

Date Collected (Month, Day, Year) ____________

Due to Serious Injuries Hold Until (Month, Day, Year) ____________

Veh. and Ped. # Assignment (Vehicles and Pedestrians described in this form are identified as follows:)

Veh. # ____ = } (INDICATE YEAR, MAKE AND MODEL) ____________

Veh. # ____ = ____________

Ped. # ____ = } (ASSIGN NOS. IN SEQUENCE OF CONTACT--INDICATE AGE AND SEX OF EACH PEDESTRIAN.) Age: ______ Sex: ______

Ped. # ____ = Age: ______ Sex: ______

Ped. # ____ = Age: ______ Sex: ______

Data Source

1. Driver of Accident Veh. # ____
2. Passenger of Accident Veh. # ____
3. Pedestrian # ____
4. Policeman
5. Witness
6. Other ____________

CONTACT RECORD

DATE	TIME	CONTACTED BY	MANNER OF CONTACT	RESULTS

INVESTIGATOR COMMENTS: ______________________________

____

9/77 Form 006

PEDESTRIAN INJURY CAUSATION STUDY

HUMAN DATA

GENERAL ACCIDENT DESCRIPTION

Provide a Narrative Description of the Accident Sequence. ______________________

PRE-IMPACT DATA - VEHICLE

	Veh. #	Veh. #
(INSERT VEHICLE #)	__	__
Travel Direction 1. North 3. South 8. Not Applicable 2. East 4. West 9. Unknown	__	__
Travel Lane (Numbered from curb or shoulder to center) 1. 1st Lane 3. 3rd Lane 5. Other ______ 8. NA 2. 2nd Lane 4. 4th Lane ______ 9. Unk.	__	__
Estimated Travel Speed 00 Stopped or Parked 01-96 Actual Speed 97 97 or More 98 Not Applicable 99 Unknown	__ __	__ __
Vehicle Activity Prior to Accident Sequence Driver Controlled 01 Going Straight 02 Right Turn 03 Left Turn 04 U-Turn 05 Changing Lanes 06 Passing 07 Backing 08 Parking 09 Leaving Parked Position 10 Starting in Roadway Not Driver Controlled Sliding, Leading: 21 with Front 22 with Right 23 with Left 24 with Rear 24 Rotating: 25 Clockwise 26 Counterclockwise 97 Other 98 Not Applicable 99 Unknown	__ __	__ __
Velocity Data 01 Slowing 02 Accelerating 03 Traveling at Constant Velocity 04 None: Stopped in Traffic 05 None: Double Parked 06 None: Parked, Not in Traffic 99 Unknown	__ __	__ __
Attempted Avoidance Maneuver 00 None 01 Braking 02 Steering Left 03 Steering Right 04 Braking and Steering Left 05 Braking and Steering Right 06 Accelerating 07 Accel. and Steer. Left 08 Accel. and Steer. Right 09 Brake Release 10 Other ______ 98 Not Applicable 99 Unknown	__ __	__ __

9/77 Form 006

PEDESTRIAN INJURY CAUSATION STUDY

HUMAN DATA

PRE-IMPACT DATA - PEDESTRIAN | Ped. #

(INSERT PEDESTRIAN #)

Accident Site
1. Intersection, Crosswalk
2. Intersection, No Crosswalk
3. Non-Intersection, Crosswalk
4. Non-Intersection, No Crosswalk
7. Other ________
8. Not Applicable
9. Unknown

Pedestrian Location
1. On Road
2. On Sidewalk
3. On Shoulder
4. On Median
7. Other ________
8. Not Applicable
9. Unknown

Travel Direction
1. North
2. East
3. South
4. West
8. Not Applicable
9. Unknown

Pedestrian Activity
01 Waiting for bus, taxi, light change, etc.
02 Working on vehicle
03 Working in roadway or environs
04 Getting in or out of vehicle
05 Hitchhiking
06 Vendor (truck, pushcart, etc.)
07 Crossing with signal
08 Crossing against signal
09 Crossing in front of school bus
10 Crossing behind school bus
11 Crossing in front of other bus
12 Crossing behind other bus
13 Crossing street to catch bus or other vehicle
14 Crossing between parked vehicles
15 Crossing, no parked vehicles nearby
16 Playing in road
97 Other ________
98 Not Applicable
99 Unknown

Attitude
1. Standing
2. Sitting
3. Crouching
4. Kneeling
5. Bending at waist
7. Other ________
9. Unknown

Type of Motion
01 Walking
02 Walking rapidly
03 Running
04 Hopping
05 Skipping
06 Jumping
07 Skating
08 On Skateboard
09 Falling or rising
97 Other ________
98 Not Applicable
99 Unknown

Pedestrian Action Relative to Traffic
01 Crossing road, straight
02 Crossing road, diagonally
03 Moving in road, with traffic
04 Moving in road, against traffic
05 Off road, approaching road
06 Off road, leaving road
07 Off road, moving parallel
08 Off road, crossing driveway
09 Off road, moving along driveway
97 Other ________
98 Not Applicable
99 Unknown

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

HUMAN DATA

PRE-IMPACT DATA - PEDESTRIAN (Continued) — Ped. #

(INSERT PEDESTRIAN #) ___ ___ ___

Body Orientation Relative to Vehicle ___ ___ ___

1. Facing vehicle
2. Facing away
3. Left side to vehicle
4. Right side to vehicle
7. Other ________
8. Not Applicable
9. Unknown

Attempted Avoidance Maneuver -- -- --

01 Stopped
02 Accelerated pace
03 Ran away (along veh. path)
04 Jumped
05 Turned toward vehicle
06 Turned away from vehicle
07 Dove or fell away

Used hands to:
11 Vault corner of vehicle
12 Vault onto vehicle
13 Brace against vehicle
21 Crouched & braced hands against vehicle
97 Other ________
98 Not Applicable
99 Unknown

Est. Imp. Speed: 00 Stopped; 01-96 Actual Speed; 97 97 or More, 98 NA; 99 Unk. --
Error Range: 00-10 Actual Range (+ or-); 98 NA; 99 Unk. --
Data Source: 1 Calc.; 2 Throw Dist.; 3 Wit., Dr., est.; 4 Inj./Sp. Curve; 9 Unk. -

IMPACT DATA - VEHICLE — Veh. #

(INSERT VEHICLE #)

Location of First POI* ___ ___

1. On Road (includes shopping mall roads)
2. On Shoulder
3. On Median
4. Off Road (beyond shoulder area)
5. Sidewalk
7. Other ________
8. Not Applicable
9. Unknown

*If coded 2 to 9, Code 8 Below

Travel Lane Number (Numbered from curb or shoulder to center) ___ ___

1. 1st Lane
2. 2nd Lane
3. 3rd Lane
4. 4th Lane
5. Other ________
6. Center of Roadway
8. Not Applicable
9. Unknown

Travel Lane Direction ___ ___

1. North
2. East
3. South
4. West
5. Center of Roadway
8. Not Applicable
9. Unknown

Estimated Impact Speed -- --

00 Stopped
01-97 Actual Speed
98 Not Applicable
99 Unknown

IMPACT DATA - PEDESTRIAN — Ped. #

(INSERT PEDESTRIAN #) ___ ___ ___

Body Orientation Relative to Vehicle ___ ___ ___

1. Facing vehicle
2. Facing away
3. Left side to vehicle
4. Right side to vehicle
7. Other ________
9. Unknown

Head Position ___ ___ ___

1. To front
2. To left
3. To right
4. Up
5. Down
7. Other ________
9. Unknown

9/77 Form 006

PEDESTRIAN INJURY CAUSATION STUDY
HUMAN DATA

IMPACT DATA - PEDESTRIAN (Continued) | Ped. #

(INSERT PEDESTRIAN #) ___ ___ ___

Arm Position

01 At sides
02 Folded across chest
03 Hands clasped behind back
04 Hands on hips
05 Hands in pockets
One or both arms:
06 Extended upward
07 Extended to side
08 Extended forward, bracing
09 Extended forward, other
10 Holding briefcase, suitcase, shopping bag, etc. at side
11 Holding parcel, young child, etc. in arm(s)
12 Holding parcel, young child, etc. on shoulder(s) or head
97 Other ____________
99 Unknown

-- | -- | --

Leg Position

01 Together
02 Apart, laterally
03 Apart, left leg forward
04 Apart, right leg forward
05 Apart, forward leg unknown
06 Left foot off ground
07 Right foot off ground
08 Both feet off ground
97 Other ____________
98 Not Applicable
99 Unknown

-- | -- | --

Contact Sequence, Impact Location, and Vehicle Orientation at Impact (Accident Viewpoint)

Impact No.	Body Area Contacted[1]	Vehicle No.	Impact Loc.[2]	Veh. Orient.[3]	Vehicle No.	Impact Loc.[2]	Veh. Orient.[3]	Object Contacted[4]
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

Select Appropriate Codes from List Below:

1 Body Area Contacted
1. Head
2. Neck
3. Thorax
4. Abd./Pelvis
5. Arms
6. Legs
7. Other ____________
8. Not Applicable
9. Unknown

2 Veh. Impact Location
1. Front
2. Right Side
3. Rear
4. Left Side
5. Top
6. Undercarriage
7. Other ____________
8. Not Applicable
9. Unknown

3 Vehicle Orientation
1. Tracking, No Skidding
2. Tracking, Skidding
3. Rotated Clockwise to Path of Travel
4. Rotated Counterclockwise to Path of Travel
5. Rolling Over
6. Other ____________
8. Not Applicable
9. Unknown

4 Object Contacted
1. Guardrail
2. Curb/Raised Median
3. Ground
4. Tree
5. Pole
6. Sign
7. Other ____________
8. Not Applicable
9. Unknown

PEDESTRIAN INJURY CAUSATION STUDY

HUMAN DATA

POST-IMPACT DATA - VEHICLE

Veh.

(INSERT VEHICLE #) ___ ___

Driver Inputs Between Last POI and FRP __ __ | __ __

00 None
01 Braking
02 Steering Left
03 Steering Right
04 Braking and Steering Left
05 Braking and Steering Right
06 Acceleration Followed by Braking
07 Acceleration Followed by Braking and Steering
08 Brake Release
09 Vehicle Came to Rest at Last POI
10 Other ______________________
98 Not Applicable
99 Unknown

If multiple impacts were involved, describe driver inputs between initial POI and last POI. ______________________

____

Estimate of Distance Traveled Between Initial POI and FRP __ __ __ | __ __ __

000 Came to Rest at Initial POI — 998 Not Applicable
Use Actual Distance (25 feet = 025) — 999 Unknown

Estimate of Distance Traveled Between Final POI and FRP __ __ __ | __ __ __

000 Came to Rest at Final POI — 998 Not Applicable
Use Actual Distance (25 feet = 025) — 999 Unknown

Final Rest Position (FRP) ___ | ___

1 On Roadway
2 On Shoulder
3 On Median
4 Off Roadway (beyond shoulder area)
5 Other ______________
8 Not Applicable
9 Unknown

POST-IMPACT DATA - PEDESTRIAN

Ped. #

(INSERT PEDESTRIAN #) ___ ___ ___

Estimate of Distance Traveled between Initial POI and FRP __ __ __ | __ __ __ | __ __ __

000 Came to Rest at Initial POI — 998 Not Applicable
Use Actual Distance (25 feet = 025) — 999 Unknown

Estimate of Distance Traveled Between Final POI and FRP __ __ __ | __ __ __ | __ __ __

000 Came to Rest at Final POI — 998 Not Applicable
Use Actual Distance (25 feet = 025) — 999 Unknown

Final Rest Position (FRP) ___ | ___ | ___

1 On Vehicle
2 On Road
3 On Shoulder
4 On Median
5 On Sidewalk
6 Off Road (beyond shoulder area)
7 Other ______________
8 Not Applicable
9 Unknown

PEDESTRIAN INJURY CAUSATION STUDY
HUMAN DATA

POST-IMPACT DATA - PEDESTRIAN (Continued)

(INSERT PEDESTRIAN #) Ped. # ___ ___ ___

Vehicle/Pedestrian Interaction

Front or Corner Impact

01 Carried by veh.
02 Carried by veh., wrapped position
03 Carried by veh., slid to windshield
04 Rotated over veh. top
05 Thrown straight forward
06 Thrown forward and left of veh.
07 Thrown forward and right of veh.
08 Knocked to pavement, forward
09 Knocked to pavement, left of veh.
10 Knocked to pavement, right of veh.
11 Knocked to pavement, run over or dragged
12 Shunted to left (corner impacts only)
13 Shunted to right (corner impacts only)
17 Other ___________
19 Unknown

Side Impact

21 Knocked to pavement
22 Bumped or pushed aside
23 Snagged, rotated
24 Snagged, dragged by veh.
25 Feet or legs run over
27 Other
29 Unknown

__ __   __ __   __ __

Rear Impact

31 Carried by veh.
32 Carried by veh., wrapped position
33 Thrown rearward
34 Thrown rearward and left of veh.
35 Thrown rearward and right of veh.
36 Knocked to pavement, rearward
37 Knocked to pavement, left of veh.
38 Knocked to pavement, right of veh.
39 Knocked to pavement, run over or dragged
40 Shunted to left (corner impacts only)
41 Shunted to right (corner impacts only)
47 Other ___________
49 Unknown

99 Unknown

Accident Diagram (Draw a rough sketch of the accident sequence; include at impact and final rest positions.)

Where is car now? (If not examined earlier) ______________________

DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY
ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY
HUMAN DATA

	Pedestrian and Vehicle Number	Pedestrian Number 1	Pedestrian Number 2	Pedestrian Number 3	Driver Veh. 1	Driver Veh. 2
00 Less than one year 01-97 Actual age 98 98 years or older 99 Unknown	Age					
1 Male 2 Female 9 Unknown	Sex					
0 None 2 Intoxicated 1 Had Been Drinking 9 Unknown	Alcohol Involvement					
15-98 Actual Height in Inches 99 Unknown	Overall Height				X	X
000-998 Actual Weight in Lbs. 999 Unknown	Weight				X	X
(Measure in inches, <u>include appropriate heel height</u>) Ground to Knee Ground to Hip (Measured in inches) Ground to Shoulder Neck Length	Height Detail	___ ___ ___ ___	___ ___ ___ ___	___ ___ ___ ___	X	X
Heel Height (Measured in inches)	Shoe Heel Measurement				X	X
0 Not Injured 9 Unknown if Injured 1 Injured	Injury Status				X	X
0 None 1 First Aid at Scene 2 Transport to Hospital/ Clinic 3 Private Physician 8 Other ____________ 9 Unknown	Treatment				X	X
Was pedestrian aware that vehicle was backing or approaching? 1 Yes 2 No 9 Unknown	Pedestrian Awareness				X	X

(If pedestrian was transported to a hospital or clinic, indicate the transporting unit and the name of the hospital or clinic.) ____

____

9/77 Form 006

PEDESTRIAN INJURY CAUSATION STUDY

HUMAN DATA

PEDESTRIAN NO. ________

		Clothing Description				
Body Area	Type	Color	Material	Weight	Pattern or Weave	Condition
Head						
Upper Torso and Arms						
Lower Torso and Legs						
Feet						

Pedestrian Clothing

Describe pedestrian clothing in as much detail as possible. If several layers of clothing are worn, describe each garment. Basic information to be recorded for each garment includes type, color, material, weight (heavy, light), pattern or weave of outer garments and condition. Identify areas that are cut, torn, abraded, stained by road materials, oil, etc. If it would be helpful, sketch the garment and indicate the location of damage or stains. The attached format should be used to describe clothing. If more room is needed, attach additional sheets. (A more detailed discussion appears in the Coding Manual.)

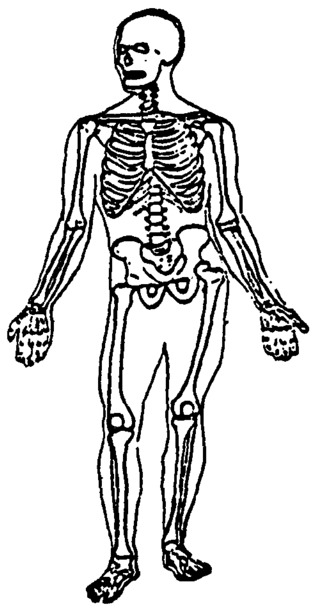
DEPARTMENT OF TRANSPORTATION
NATIONAL HIGHWAY TRAFFIC SAFETY
ADMINISTRATION

PEDESTRIAN INJURY CAUSATION STUDY

HUMAN DATA

INJURY DATA

PEDESTRIAN # ___ Indicate the nature, location, and injury source of all injuries.



Outpatient Visits ___

- 0 None
- 1-6 Actual Number
- 7 7 or More
- 8 NA (Not Injured)
- 9 Unknown

Activity Restriction (Actual Days)

Bed Rest ___ ___

Other Restriction (Describe ___ ___ ___

____

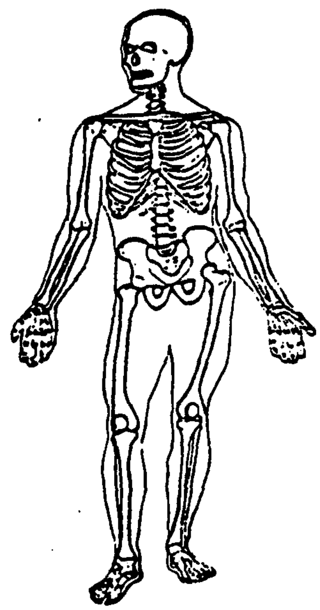
Work Days Lost ___ ___

Days in Hospital ___ ___

Long Term Disabilities ___

0. None Sustained 9. Unknown
1. Disability Sustained
(Describe ________________________________
________________________________)

PEDESTRIAN # ___ Indicate the nature, location, and injury source of all injuries.



Outpatient Visits ___

- 0 None
- 1-6 Actual Number
- 7 7 or More
- 8 NA (Not Injured)
- 9 Unknown

Activity Restriction (Actual Days)

Bed Rest ___ ___

Other Restriction (Describe ___ ___ ___

____

Work Days Lost ___ ___

Days in Hospital ___ ___

Long Term Disabilities ___

0. None Sustained 9. Unknown
1. Disability Sustained
(Describe ________________________________
________________________________)

C

TEAM	YEAR	MONTH	DAY	SEQUENCE
__	__	__ __	__ __	__ __ __

PEDESTRIAN INJURY CAUSATION STUDY

PEDESTRIAN BEHAVIOR - CHILDREN

PED. NO. ☐

COMPLETE THIS FORM FOR ALL ACCIDENTS INVOLVING CHILDREN UNDER THE AGE OF EIGHTEEN.

1. What activity was child engaged in immediately prior to accident?[1]
   ____ Going to/from school
   ____ On errand for parents

   Select one:

   ____ Directed walking
   ____ Non-directed walking
   ____ Non-directed running
   ____ Chasing
   ____ Kickball
   ____ Throwing/catching ball
   ____ Non-directed behavior in a confined area
   ____ Throwing object at someone
   ____ Directed running
   ____ Directed behavior in a confined area

   ____ Other. Describe ____________

   ____ Stickball
   ____ Throwing object/catching rebound
   ____ Flying kite
   ____ Jumping rope
   ____ Fighting/wrestling
   ____ Riding skateboard
   ____ Non-directed throwing
   ____ Football
   ____ Baseball
   ____ Roller skating
   ____ Tennis
   ____ Street hockey
   ____ Basketball

2. Did parked cars obscure driver's vision of child prior to the collision?

   No ____ Yes ____ Unknown ____

3. Was there adult supervision present? No ____ Yes ____ Unknown ____

4. Distance between locus of child's activity prior to the accident and the point where struck (in feet). ________

   Child's pre-involvement activity was ____ in the street
   ____ not in the street
   ____ unknown.

5. Had the child ever been struck by a vehicle or previously experienced "close calls"?

   No ____ Yes ____ Unknown ____

   If yes, number of times struck ________; number of near misses ________.

6. When the accident occurred, what was the size of the group in which the child was playing? (Indicate 1 if child playing alone.) ________

   What was the age of the oldest child in the group? _____; youngest _____?

[1] See definitions.

5/79 1

ZS-6117-V-1

7. What was the type of area in which the accident occurred?

____ Commercial
____ Industrial
____ Residential
____ Residential/Commercial

If residential or residential/commercial, what type of housing?

____ single family
____ row houses or townhouses
____ 2-6 unit apartments
____ larger than 6-unit apartments.

8. What alternate play sites were available within one block in any direction from the accident site? (Check all that apply.)

____ Improved vacant lot
____ Unimproved vacant lot
____ Back yards--size in feet ______
____ Front yards--size in feet ______
____ Park
____ Playground
____ Other (Specify) ____________________

9. Distance of accident site from the child's home (in city blocks or fraction of block)? ______

UI

TEAM	YEAR	MONTH	DAY	SEQUENCE
_	_	_ _	_ _	_ _ _

PEDESTRIAN INJURY CAUSATION STUDY

PED. NO. [ ]

PEDESTRIAN BEHAVIOR - URBAN INTERSECTION ACCIDENTS

COMPLETE THIS FORM FOR ALL URBAN INTERSECTION ACCIDENTS. (SEE MANUAL FOR DEFINITIONS.)

1. SCHEMATIC CHECKLIST

BE SURE THAT ALL OF THE ITEMS SPECIFIED BELOW APPEAR ON THE ACCIDENT SCHEMATIC.

a. All legs of the intersection.
b. The active traffic lanes in each leg, including special turn lanes.
c. Parking lanes on each leg and the presence of parked vehicles on all legs.
d. Direction of traffic flow on each leg.
e. Path of impacting vehicle showing:
   (1) Point where pedestrian was first observed by the driver
   (2) Point where driver evasive action was first attempted, if any
   (3) Collision point
f. Path of pedestrian (from about 20 paces prior to street entry).
   (1) Point where pedestrian was first aware of the threatening vehicle
   (2) Point where pedestrian was first aware that collision was imminent and possibly attempted evasive action
g. Name of the city and all street names.
h. Street widths.
i. The scale, particularly as related to vehicle and pedestrian paths.

2. The pedestrian was crossing:
   a. ____ by himself/herself.
   b. ____ with a companion, same sex.
   c. ____ with a companion, opposite sex.
   d. ____ with two or more persons.
   e. ____ Unknown

3. Prior to entering the street, the pedestrian:
   a. ____ stopped and/or waited.
   b. ____ paused
   c. ____ did not pause or change speed of movement.
   d. ____ Other, specify ____________

4. Immediately prior to being struck, the pedestrian's speed of movement can best be described as:
   a. ____ slow walk.
   b. ____ normal walk.
   c. ____ fast walk.
   d. ____ slow run (i.e., trot or jog).
   e. ____ fast run.
   f. ____ Other, specify ____________

5. The pedestrian's search behavior can best be described as follows (inlcude only those search behaviors which occurred before it was too late to avoid the accident):
   a. ____ searched at least the direction from which he/she was struck.
   b. ____ made some searches but no search was made in the direction from which he/she was struck.
   c. ____ no searches in any direction.
   d. ____ some searches were performed, but they were too early, i.e., the searches occurred before the offending vehicle was visible or could be judged to be a threat. (Ex. searches well before the curb or searches coupled with slow gait which permitted threatening vehicle to appear unnoticed while the pedestrian was in the street.)
   e. ____ Other, specify ____________

6. Was the pedestrian distracted (i.e., attending to something in the intersection other than, or in addition to, traffic) during the time when he/she could have been searching?
   a. ____ no.
   b. ____ yes, the pedestrian was engaged in conversation.
   c. ____ yes, other. Specify ____________

7. Immediately prior to being struck was the pedestrian emotionally aroused or preoccupied such that his/her attention was not directed to the crossing situation?
   a. ____ no.
   b. ____ yes. Describe: ____________

8. Did the pedestrian detect the vehicle in sufficient time to avoid the accident?
   a. ____ no. If 8a was checked, why didn't the pedestrian detect the vehicle? ____________
      ____ yes. If yes, why didn't the pedestrian act before it was too late to avoid the accident? Check b to g below.
   b. ____ both the pedestrian and the driver reacted in a way which re-established the collision course.
   c. ____ the pedestrian believed that the vehicle was going to yield the right-of-way (i.e., change course or speed to pass safely in front of or behind him).
   d. ____ the pedestrian believed that the vehicle was going to stop for a Stop/Yield sign or a signal prior to hitting him.
   e. ____ the pedestrian believed that the vehicle was going to turn the corner prior to hitting him.
   f. ____ the pedestrian misjudged the speed of the approaching vehicle, or his own ability to move out of the vehicle's path.
   g. ____ Other, Specify ____________

5/79

9. Did the pedestrian perform an unusual or driver-unanticipated act which contributed to the accident?
   a. ____ appeared suddenly from behind a vehicle parked at the curb.
   b. ____ appeared suddenly from behind some obstruction other than a vehicle parked at the curb. Specify the nature of obstruction (include double parked or standing vehicles). ________________
   c. ____ entered street suddenly from curbside (the pedestrian must have been visible to the driver prior to the street entry).
   d. ____ changed rate of movement or direction without warning while crossing.
   e. ____ other unusual/unanticipated act. Specify ________________

10. Were there other pedestrians in the crosswalk at the time of the accident; other than companions of the victim?
    a. ____ no.
    ____ yes. If yes, did the pedestrian believe that their presence made it safer for him/her to cross the street?
       b. no.
       c. yes. If yes, why? ________________
    d. ____ Unknown if other pedestrians present.

11. At the time of the accident, the vehicle was:
    a. ____ proceeding straight ahead.
    b. ____ about to make a right turn.
    c. ____ making, or had just completed, a right turn.
    d. ____ about to make a left turn
    e. ____ making, or had just completed, a left turn.
    f. ____ Other, specify ________________

12. Was there an indication that, immediately prior to the accident, the driver was: (Check all that apply)
    a. ____ running a traffic signal or stop sign.
    b. ____ attempting to "beat" the light.
    c. ____ attempting to "jump" the light.
    d. ____ "clearing" the intersection; i.e., making a left turn after waiting in the intersection and after the signal had turned red against him.
    e. ____ speeding.
    f. ____ swerving or changing lanes suddenly
    g. ____ out of control of the vehicle.
    h. ____ on the wrong side of the road.
    i. ____ pulling through the crosswalk to stop (e.g., in order to have a better view of cross traffic).
    j. ____ none of the above.

13. The traffic control condition in effect on the leg where the pedestrian was struck was:
    a. ____ no control.
    b. ____ stop or yield.
    c. ____ signal present, pedestrian crossed on green or walk.
    d. ____ signal present, pedestrian crossed on red or don't walk
    e. ____ signal present, pedestrian crossed as light changed from green to red for him/her during crossing.
    f. ____ signal present, pedestrian crossed as light changed from red to green for him/her during crossing.
    g. ____ Unknown

APPENDIX 4

Representativeness of Pedestrian Accident Data

Base Rate Data File

An essential aspect of the PICS project was to determine whether pedestrian accident data collected by the teams was representative of the pedestrian accident population within the various data collection areas. For this purpose, base rate data were collected by each of the data collection teams. To obtain the base rate data, copies of all police reported pedestrian accidents occurring within the data collection area were collected by the teams throughout the study.

The information from the police reports was translated into a uniform coding format, keypunched, and stored on a SAS file. The elements in the base rate data file are:

Team	Jurisdiction
Month	Time
Date	Number of Pedestrians Involved
Year	Impact Type
Pedestrian Age	Vehicle Type
Pedestrian Sex	Intersection
Pedestrian Injury	Road Condition
Pedestrian Action	

In order to prevent the base rate data file from becoming too large and complex, multiple vehicle and pedestrian accidents were categorized by the major event, i.e., the first pedestrian and the striking vehicle were selected to represent the accident. Although this selection eliminates some vehicle and pedestrian information, the overall accident description is generally the same.

The data from the sample plans of each team were subsequently compared to the base rate data from the corresponding time period. The results of these comparisons are presented in this section.

In analyzing the variables related to the time of accident occurrence, i.e., day of the week, month and hour, the assumption was made that these variables were independent; for example, that a pedestrian accident occurring at any given time was just as likely to occur on a weekday as on a weekend. While this assumption is probably not true in the strictest sense, it was believed that any violations of independence would have little effect on the data's interpretation. It should also be noted that all comparisons were made after adjustment of the investigated accident data for sampling.

Calspan Base Rate

Tables A-1, A-2, and A-3 present the frequency distribution of the day of week, the time and the month in which the accident occurred, respectively, for the base rate data. The format for the monthly distribution of pedestrian accidents differs slightly from the others. The number of accidents in each month and year is shown, followed by an average number over the entire data collection phase. February 1980 is excluded from the average calculations, since base rate data were collected for only that portion of the month during which data collection was conducted. Data collection concluded on February 14, 1980.

TABLE A-1.- BASE RATE DISTRIBUTION OF DAY OF WEEK - CALSPAN

	Phase I		Phase II		Phase III		Total	
Day of Week	N	%	N	%	N	%	N	%
Sunday	16	9.1	89	9.4	39	8.1	144	9.0
Monday	35	20.0	124	13.1	79	16.4	238	14.9
Tuesday	27	15.4	121	12.8	66	13.7	214	13.4
Wednesday	21	12.0	159	16.8	71	14.7	251	15.7
Thursday	19	10.9	146	15.5	83	17.2	248	15.5
Friday	31	17.7	167	17.7	70	14.5	268	16.7
Saturday	26	14.9	139	14.7	74	15.4	239	14.9
TOTAL	175	100.0	945	100.0	482	100.0	1602	100.0

TABLE A-2. - BASE RATE DISTRIBUTION OF HOUR OF ACCIDENT - CALSPAN

Time of Accident	Phase I		Phase II		Phase III		Total	
	N	%	N	%	N	%	N	%
0000 - 0600	16	9.2	90	9.6	38	7.9	144	9.0
0600 - 1200	24	13.9	185	19.7	57	11.9	266	16.7
1200 - 1800	78	45.1	437	46.4	232	48.3	747	46.9
1800 - 2400	55	31.8	229	24.3	153	31.9	437	27.4
Unknown	2	--	4	--	2	--	8	--
TOTAL	175	100.0	945	100.0	482	100.0	1602	100.0

TABLE A-3. - MONTHLY DISTRIBUTIONS OF BASE RATE PEDESTRIAN ACCIDENTS, BY YEAR - CALSPAN

Month	1977	1978	1979	1980	Average	%
January		60	59	54	58	9.2
February		52	55	23*	54	8.6
March		55	61		58	9.2
April		45	36		41	6.5
May		65	53		59	9.4
June		63	57		60	9.5
July		47	37		42	6.7
August	59	51	34		48	7.6
September	56	60	44		53	8.4
October	57	57	44		53	8.4
November	48	54	42		48	7.6
December	60	53	58		57	9.0
Unknown	3				3	--
TOTAL	283	662	580	77	634	100.0

*Not included in average calculation

Since the sampling plans used by Calspan were quite different from one another, the data from each plan will be compared to the base rate data separately. The first sampling plan lasted only three months (August - October, 1977). The day of the week and time of accident from the data collected during this time period is summarized in Table A-4 - a bivariate table of the two variables. The marginals for both the variables were used to compare the respective distributions to the appropriate base rate totals.

TABLE A-4. - JOINT DISTRIBUTION OF TIME BY DAY OF WEEK (WEIGHTED) - CALSPAN PHASE I

Day	0000 - 0600	0600 - 1200	1200 - 1800	1800 - 2400	Total
Sunday	1	0	0	4	5 (4.6)*
Monday	0	0	11	0	11 (10.1)
Tuesday	0	0	8	0	8 (7.3)
Wednesday	0	31	4	11	46 (42.2)
Thursday	0	0	8	0	8 (7.3)
Friday	0	0	0	11	11 (10.1)
Saturday	1	0	19	0	20 (18.3)
TOTAL	2(1.8)	31(28.4)	50(45.9)	26(23.9)	109(100.0)

*Figures in parentheses are percentage of grand total

There are significant and meaningful differences between the distributions of the day of the week ($X_6^2 = 64.2$; $p \leq 0.001$; $\phi' = .77$) and the time of occurrence ($X_3^2 = 15.7$; $p \leq 0.005$; $\phi' = .38$). In examining Table A-4, note the entry in the cell for Wednesday between 0600 and 1200. This is the result of a single accident which had a weighting factor of 30.7 (the cell frequency is rounded). In effect, this observation has overwhelmed the rest of the data; in order to obtain the same proportion of 0600 - 1200 accidents that was evidenced in the base rate data, 186 weighted observations would be necessary. If the accident in question had not occurred, then the proportion of 0600 - 1200 accidents would have been much too low. Thus, the deviations in the sampled data from the base rate data that were detected during this first sampling plan seem to be primarily a function of the short length of time the plan was in operation. It is noted that a similar effect was evident in the distribution of pedestrian accidents by the month in which they occurred.

The second sampling plan used by Calspan did not suffer from a short duration; it lasted fifteen months. The bivariate distribution of day by time of accident is given in Table A-5.

TABLE A-5. - TIME BY DAY OF THE WEEK FOR PHASE II (CALSPAN) (WEIGHTED)

Day	0000 - 0600	0600 - 1200	1200 - 1800	1800 - 2400	Total	
Sunday	1	6	29	0	36	(6.9)*
Monday	0	98	36	0	134	(25.6)
Tuesday	7	0	56	18	81	(15.5)
Wednesday	7	7	55	25	94	(18.0)
Thursday	2	0	56	25	83	(15.9)
Friday	0	1	50	25	76	(14.5)
Saturday	1	0	17	1	19	(3.6)
TOTAL	18(3.4)	112(21.4)	299(57.2)	94(18.0)	523	(100.0)

*Percentage of grand total

Examination of this table indicates that there are two large discrepancies with the base rate data that are immediately obvious. First is the excessive number of accidents which occur between 1200 and 1800. Of the investigated accidents, 57.2% happened during this time interval, despite the fact that only 46.9% of the base rate accidents were recorded in that interval. There is a meaningful difference between the two distributions, as evidenced by a coefficient of contingency of 0.32. This is based on a X^2 value of 53.6 (3d.f.).

Furthermore, the proportion of Saturday pedestrian involvements which were investigated in the field is appreciably below the expected level, i.e., 3.6% instead of 14.9%. This deviation is also of statistical and practical significance ($X_6^2 = 92.5$; $p \leq 0.001$; $\phi' = 0.42$).

It was initially believed that this result was caused by a peculiarity in the sample weight calculations. It may be recalled that for accidents taken on Mondays from 0700 to 1300, the sample fraction was based on the number of Mondays that data were collected to the number of Mondays within the phase's data collection period. Thus, these accidents were generalizable to Mondays only, rather than all weekdays. Similarly, afternoon pedestrian accidents on Tuesday through Friday were adjusted to Tuesdays through Fridays; Mondays were not considered. Consequently, the sampling fractions were adjusted so that a Monday through Friday accident could be generalized to all five weekdays. This effort did not, however, improve the degree of correspondence between the two samples. In any event, this would not have affected the surprisingly low percentage of Saturday accidents within the sample.

It should also be remembered that it was for this particular sample plan that the sampling fractions for pedestrian accidents which occurred within the City of Buffalo were adjusted, since it could not be determined whether the accident happened in the core or a supplemental data collection area. The accidents were apportioned on the basis of population and historical data. The historical data were not broken down by time and day of occurrence. Thus, if the frequency of pedestrian accidents was elevated during daylight weekday hours, and if the incidence was low throughout the weekends, these facts would not have been evident.

This is also consistent with the fact that the "population" of the core area is higher during the time period of interest. Essentially, the core area is the Buffalo business district, and there is a large influx of commuters. In addition, since the area is mostly commercial, there would be fewer people there during the nights and weekends. (Note that the proportion of Sunday accidents is slightly lower too.)

Within the constraints of the current study adequate resources are not available to investigate this supposition further. However, if such an effort is to be considered at a later date, it is suggested that the precinct number be added to the data record. In this way, there would be no confusion concerning the area (core or supplemental) in which the accident occurred.

In the third sampling scheme utilized by Calspan, the distributions of the sampling variables were in much better agreement with the base rate data. Table A-6 is a joint distribution of time of day and the day of the week: It is followed by a univariate frequency distribution of the number of cases by month.

TABLE A-6. - SAMPLING PLAN 3: TIME OF DAY BY DAY OF WEEK (CALSPAN) (WEIGHTED)

Day	0000 - 0600	0600 - 1200	1200 - 1800	1800 - 2400	Total
Sunday	0	5	9	7	21 (7.1)*
Monday	0	19	14	8	41 (13.9)
Tuesday	3	2	28	10	43 (14.6)
Wednesday	0	4	19	11	34 (11.5)
Thursday	3	5	32	24	64 (21.7)
Friday	3	6	22	19	50 (16.9)
Saturday	6	2	24	10	42 (14.2)
TOTAL	15(5.1)	43(14.6)	148(50.2)	89(30.2)	295 (100.0)

*Percentage of grand total

A X^2 goodness-of-fit test to the base rate day of the week distribution is not significant ($X_6^2 = 12.3$) and a similar test using the time of day does not result in a statistical significance ($X_3^2 = 7.3$). In this regard, if the Phase III weighted data are compared to only the base rate data which were collected during that sampling plan, no significant differences are found for either variable.

The monthly frequencies are presented below in Table A-7. A X^2 goodness-of-fit test failed to detect a significant difference between these data and the base rate data from the same time period (X^2_{10} = 8.27).

TABLE A-7. - MONTHLY ACCIDENT FREQUENCIES
(CALSPAN PHASE III)
(WEIGHTED)

Month	N	%
April 1979	22	7.5
May 1979	30	10.3
June 1979	32	11.0
July 1979	18	6.2
August 1979	25	8.6
September 1979	30	10.3
October 1979	29	9.9
November 1979	25	8.6
December 1979	34	11.6
January 1980	29	9.9
February 1980	18	6.2
TOTAL	292	100.0

SWRI Base Rate Data

The three sampling plans which were employed by Southwest Research Institute were very similar to one another, and hence, will be analyzed as one. The changes that were implemented involved increasing the emphasis on those time periods which had the most pedestrian accidents; the level of effort on the other sample periods was not reduced.

The base rate data from SWRI is given in Tables A-8 through A-10 for the time of day, day of the week, and month and year respectively. The tabulation categorizes the data for each of the three phases of data collection.

TABLE A-8. - SWRI BASE RATE DATA - HOUR OF ACCIDENT

Time	Phase I N	Phase I %	Phase II N	Phase II %	Phase III N	Phase III %	Total N	Total %
0000 - 0600	15	7.1	84	8.5	17	8.1	116	8.2
0600 - 1200	36	17.1	149	15.1	36	17.1	221	15.7
1200 - 1800	94	44.6	426	43.2	81	38.4	601	42.7
1800 - 2400	66	31.3	328	33.2	77	36.5	471	33.4
Unknown	0	--	16	--	2	--	18	--
TOTAL	211	100.0	1003	100.0	213	100.0	1427	100.0

TABLE A-9. - SWRI BASE RATE DATA - DAY OF WEEK

Day of Week	Phase I N	Phase I %	Phase II N	Phase II %	Phase III N	Phase III %	Total N	Total %
Sunday	29	13.7	114	11.4	27	12.7	170	11.9
Monday	24	11.4	131	13.1	20	9.4	175	12.3
Tuesday	36	17.1	142	14.2	22	10.3	200	14.0
Wednesday	21	10.0	116	11.6	40	18.8	177	12.4
Thursday	27	12.8	149	14.9	32	15.0	208	14.6
Friday	38	18.0	191	19.0	37	17.4	266	18.6
Saturday	36	17.1	160	16.0	35	16.4	231	16.2
TOTAL	211	100.0	1003	100.0	213	100.0	1427	100.0

TABLE A-10. - SWRI BASE RATE DATA - PEDESTRIAN ACCIDENTS BY MONTH AND YEAR

Month	1977	1978	1979	1980	Average	%
January		29	41	42	35	6.1
February		36	45	50*	41	7.1
March		55	66		61	10.6
April		57	56		57	9.9
May		53	63		58	10.1
June		45	47		46	8.0
July		31	39		35	6.1
August	3*	52	45		49	8.5
September	57	50	36		43	7.5
October	44	51	53		52	9.1
November	47	55	48		52	9.1
December	42	43	46		45	7.8
TOTAL	193	557	585	92	574	100.0

*Partial month - not included in average computation

The base rate data just presented do not appear to have any major deviations from one sample plan to the next. Similarly, in looking at the cases that were investigated by the data collection team, the relative proportions of the time the accident occurred remained constant across the various sampling schemes. The data are shown in Table A-11; they have been adjusted for sampling.

TABLE A-11. - WEIGHTED FREQUENCY DISTRIBUTION FOR HOUR OF ACCIDENT (SWRI)

	Phase I		Phase II		Phase III		Total	
Time of Day	N	%	N	%	N	%	N	%
0000 - 0600	6	4.3	52	8.3	0	0.0	58	6.6
0600 - 1200	32	23.2	113	18.1	19	15.8	164	18.6
1200 - 1800	64	46.4	276	44.2	58	48.3	398	45.1
1800 - 2400	36	26.1	183	29.3	43	35.8	262	29.7
TOTAL	138	100.0	624	100.0	120	100.0	882	100.0

The coefficient of contingency obtained from a X^2 goodness-of-fit test does not suggest that there is a meaningful difference between the observed data and the base rate data ($X_3^2 = 12.4$; $p \leq .01$; $\phi' = 0.12$). Further evidence of the representativeness of the collected data is provided by the day of the week data element. For this variable, a goodness-of-fit statistic was not significant; a X^2 value of 7.4 was obtained (6 degrees of freedom). The data are presented in Table A-12.

TABLE A-12. - DAY OF WEEK ADJUSTED FOR SAMPLING (SWRI)

	Phase I		Phase II		Phase III		Total	
Day of Week	N	%	N	%	N	%	N	%
Sunday	18	13.0	67	10.7	6	5.0	91	10.3
Monday	15	10.9	91	14.6	12	10.0	118	13.4
Tuesday	32	23.2	89	14.3	12	10.0	133	15.1
Wednesday	14	10.1	75	12.0	17	14.2	106	12.0
Thursday	30	21.7	90	14.4	17	14.2	137	15.5
Friday	16	11.6	128	20.5	30	25.0	174	19.7
Saturday	13	9.4	84	13.5	26	21.7	123	13.9
TOTAL	138	100.0	624	100.0	120	100.0	882	100.0

In this table, it is notable that the distribution of the days of the week for the first data collection phase seems to have an overrepresentation of Tuesdays and Thursdays when compared to the data for the other two phases; there is a corresponding underrepresentation of Wednesdays as well. However, the proportion of accidents occurring on a weekday remained constant over all three data collection periods. Thus, since there is nothing to suggest that Tuesday or Thursday is different from any other weekday, it will be assumed that the variation noted is due to random error.

Finally, the distribution of accident frequency categorized by the month and year of occurrence are provided in Table A-13.

TABLE A-13. - WEIGHTED PEDESTRIAN ACCIDENTS BY MONTH AND YEAR (SWRI)

Month	1977	1978	1979	1980	Average	%
January		18	28	35	27	7.5
February		16	23	18*	20	5.6
March		36	48		42	11.7
April		44	36		40	11.2
May		44	25		35	9.8
June		33	19		26	7.3
July		26	18		22	6.1
August	1*	26	21		24	6.7
September	31	32	32		32	8.9
October	32	36	23		30	8.4
November	33	26	37		32	8.9
December	22	31	30		28	7.8
TOTAL	119	368	340	53	358	100.0

*Partial month - not included in computation of average

The average number of accidents that were computed for each of the months was compared to the corresponding figure in Table A-10. No significant differences were noted in the monthly distributions ($X_{11}^2 = 6.2$).

The pedestrian accidents collected by SWRI, then, appear to be representative of the San Antonio pedestrian accident population they were intended to reflect.

Dynamic Science Base Rate Data

Dynamic Science (DSI) also had three data collection plans. However, since the second and third were so similar (two "non-productive" areas were dropped from the data collection area), they will be treated as a single phase.

The time related variables from the base rate data are contained in Tables A-14 through A-16. As in the previous tables, the data are broken out by data collection phase as well as a combined distribution.

TABLE A-14. - BASE RATE PEDESTRIAN ACCIDENT FREQUENCY BY HOUR - DSI

	Phase I		Phase II		Total	
Time of Day	N	%	N	%	N	%
0000 - 0600	74	5.8	60	6.2	134	6.0
0600 - 1200	256	20.1	199	20.6	455	20.3
1200 - 1800	592	46.6	426	44.2	1018	45.5
1800 - 2400	349	27.5	280	29.0	629	28.1
Unknown	1	--	0	--	1	--
TOTAL	1272	100.0	965	100.0	2237	100.0

TABLE A-15. - DAY OF WEEK BASE RATE DATA (DSI)

	Phase I		Phase II		Total	
Day of Week	N	%	N	%	N	%
Sunday	148	11.6	97	10.1	245	11.0
Monday	199	15.6	143	14.8	342	15.3
Tuesday	190	14.9	135	14.0	325	14.5
Wednesday	206	16.2	145	15.0	351	15.7
Thursday	142	11.2	140	14.5	282	12.6
Friday	228	17.9	168	17.4	396	17.7
Saturday	159	12.5	137	14.2	296	13.2
TOTAL	1272	100.0	965	100.0	2237	100.0

TABLE A-16. - MONTHLY BREAKDOWN OF BASE RATE PEDESTRIAN ACCIDENT FREQUENCY (DSI)

Month	1978	1979	1980	Average	%
January		171	101	136	11.5
February		106	71	89	7.5
March	46*	179		179	15.1
April	98	107		103	8.7
May	131	105		118	9.9
June	39	82		61	5.1
July	72	30		51	4.3
August	91	73		82	6.9
September	98	59		79	6.7
October	69	77		73	6.1
November	85	76		81	6.8
December	172	98		135	11.4
TOTAL	901	1163	172	1187	100.0

*Partial month - not used to compute average

The most striking aspect of the base rate data is the variation that is evident in the number of pedestrian accidents in any given month (some of this is clearly the result of reducing the size of the sample area). As one measure of this variance, the frequency range for each month was found and an average was computed for it (March was excluded for DSI). The average range for DSI was about 34; for Calspan and SWRI, about 10. This is very interesting, since, in the design of the sampling scheme, it was found that "there is a remarkable uniformity of rates of occurrences over the months of the year".* The data referred to above was from the years 1973-1975; obviously, after several years, conditions could change. Differences were also noted in the distributions of time of day. In particular, the base rate data have a greater proportion of early morning accidents and a lesser amount of afternoon accidents than the 1973-1975 data.

*Baird, J.D. (DSI), personal communication to John W. Garrett (CFSI), February 12, 1980.

Table A-17 contains the distributions of the time of th^ accident for those accidents investigated by DSI.

TABLE A-17. - WEIGHTED FREQUENCIES FOR TIME OF DAY OF ACCIDENTS ACCIDENTS INVESTIGATED BY DSI

	Phase I		Phase II		Total	
Time of Day	N	%	N	%	N	%
0000 - 0600	25	3.3	25	3.8	50	3.5
0600 - 1200	175	22.8	130	19.7	305	21.3
1200 - 1800	380	49.5	348	52.6	728	50.9
1800 - 2400	188	24.5	158	23.9	346	24.2
TOTAL	768	100.0	661	100.0	1,429	100.0

In comparing Tables A-17 and A-14, a disparity in the relative proportions in afternoon and early morning pedestrian accidents is observed. This is similar to the difference noted previously between the base rate data and the 1973-1975 data from which the sampling plan was developed. The difference is statistically significant; a X^2 goodness-of-fit test resulted in a test statistic value of 32.7 ($p \leq 0.001$; 3 d.f.). However, a coefficient of contingency of 0.15 was obtained, indicating that the difference was not of practical significance.

TABLE A-18. - DSI FREQUENCY DISTRIBUTION OF DAY OF WEEK (WEIGHTED FOR SAMPLING)

	Phase I		Phase II		Total	
Day of Week	N	%	N	%	N	%
Sunday	80	10.4	70	10.6	150	10.5
Monday	105	13.7	98	14.8	203	14.2
Tuesday	115	15.0	123	18.6	238	16.6
Wednesday	75	9.8	78	11.8	153	10.7
Thursday	148	19.3	73	11.0	221	15.4
Friday	160	20.8	118	17.8	278	19.4
Saturday	85	11.1	103	15.5	188	13.1
TOTAL	768	100.0	663	100.0	1,431	100.0

Similar results were found using the day of the week data element. The significant goodness-of-fit test ($X_6^2 = 40.5$; $p \leq 0.001$) coupled with a relatively low ϕ', i.e., 0.17, indicates that the collected data are generally representative of the pedestrian accident population.

Interestingly, there appears to be a difference between the distribution associated with each sampling plan. A goodness-of-fit test results in a coefficient of contingency which is too large to ignore ($X_6^2 = 47.0$; $p \leq 0.001$; $\phi' = 0.27$). It would seem as if something is fundamentally different between the two samples, but nothing is immediately apparent. Furthermore, there are no systematic effects in the tabulations to suggest the source of the differences.

The accident frequency by month tabulation is given in Table A-19. There is a noticeable difference between these data and the base rate data. The effect is too large to be ignored ($X_{11}^2 = 57.2$; $p \leq 0.001$, $\phi' = 0.28$). Still, there is no apparent reason for the discrepancy. One must not rule out the possibility that the base rate data are in fact non-representative of the DSI data collection area, since they demonstrated similar deviations from the historical information and the data collected by this study. In any event, the effects, if any, of the differences on accident variables will be investigated later in this section.

TABLE A-19. - MONTHLY PEDESTRIAN ACCIDENT DISTRIBUTIONS (DSI) (WEIGHTED)

Month	1978	1979	1980	Average	%
January		75	63	69	9.6
February		80	70	75	10 4
March	55	63		59	8.2
April	65	83		74	10.3
May	50	103		77	10.7
June	40	58		49	6.8
July	50	48		49	6.8
August	50	43		47	6.5
September	70	50		60	8 4
October	65	30		48	6.7
November	55	33		44	6.1
December	50	83		67	9.3
TOTAL	550	749	133	718	100.0

Traffic Safety Research Base Rate Data

Traffic Safety Research (TSR) employed two sampling schemes throughout their data collection activities, but they were identical except for the data collection area. Thus, they will be considered as a single plan. The base rate distributions of the time of day and day of week variables are presented in Tables A-20 through A-21. Since there was only one phase, Tables A-20 and A-21 also contain the corresponding distributions for the data collected in the field; these data have been adjusted for sampling.

TABLE A-20. - TSR BASE RATE AND FIELD DATA DISTRIBUTIONS FOR HOUR OF ACCIDENT (WEIGHTED)

	Base Rate Data		Team Investigated Data	
Time of Day	N	%	N	%
0000 - 0600	116	9.3	18	2.5
0600 - 1200	193	15.4	113	15.7
1200 - 1800	538	43.0	351	48.8
1800 - 2400	403	32.2	237	33.0
Unknown	16	----	0	----
TOTAL	1,266	100.0	719	100.0

In Table A-20 there is an obvious difference between the two distributions ($X_3^2 = 41.5$; $p \leq 0.001$; $\phi' = 0.24$). This can be attributed to the low number of investigated accidents which occurred between 0000 and 0600 hours. This was, however, to be expected, since TSR's sampling plan was such that no accidents occurring between 0400 and 0700 were investigated unless they involved a fatality. In addition, no accidents during the hours between 0000 and 0400 were applicable on Monday through Friday. Thus, if only the last three time periods are compared, no significant difference can be detected between the two distributions ($X_2^2 = 1.0$; NS).

TABLE A-21. - DAY OF THE WEEK (TSR BASE RATE AND FIELD DATA WEIGHTED)

Day of Week	Base Rate Data N	Base Rate Data %	Team Investigated Data N	Team Investigated Data %
Sunday	163	12.9	87	12.1
Monday	190	15.0	88	12.2
Tuesday	180	14.2	115	16.0
Wednesday	183	14.5	100	13.9
Thursday	151	11.9	86	11.9
Friday	227	17.9	142	19.7
Saturday	172	13.6	102	14.2
TOTAL	1,266	100.0	720	100.0

Since TSR's sampling plan varied for certain time periods and days of the week, it was thought that the comparison of distribution of day of week may show some difference. However, the X^2 value of 7.4 proved the differences to be nonsignificant.

The base rate data are categorized by month and year in Table A-22. The distribution of these data is similar to that of the field investigated data (Table A-23). A goodness-of-fit test on the average number of accidents for each month yields a X^2 value of 7.0 (NS).

TABLE A-22. - MONTHLY DISTRIBUTION OF BASE RATE PEDESTRIAN ACCIDENTS (TSR)

Month	1977	1978	1979	1980	Average	%
January		37	50	40	42	8.4
February		48	47	34*	48	9.6
March		42	66		54	10.8
April		36	41		39	7.8
May		37	41		39	7.8
June		12	44		33	6.6
July		56	40		48	9.6
August	16*	33	33		33	6.6
September	21	32	41		31	6.2
October	34	48	59		47	9.4
November	33	41	48		41	8.2
December	40	48	51		46	9.2
TOTAL	144	470	561	74	501	100.0

*Partial month - not used to compute average

TABLE A-23. - TSR FIELD INVESTIGATED CASE BY MONTH AND YEAR (WEIGHTED)

Month	1977	1978	1979	1980	Average	%
January		38	22	17	26	9.1
February		18	32	15*	25	8.8
March		21	36		29	10.2
April		23	25		24	8.4
May		20	22		21	7.4
June		11	21		16	5.6
July		16	25		21	7.4
August	12*	31	20		26	9.1
September	10	14	18		14	4.9
October	27	23	32		27	9.5
November	29	23	28		27	9.5
December	36	29	23		29	10.2
TOTAL	114	267	304	32	285	100.0

*Not used to compute average value

BioTechnology Base Rate Data

BioTechnology's participation in the data collection program involved two sampling schemes, both with durations of at least nine months.

The distributions of the time of occurrence of pedestrian accidents is given in Table A-24 for the base rate data. There is a noticeable discrepancy between the two data collection phases in the accident frequencies in the late morning and early evening. No reason for this is readily apparent; the base rate data appear to be similar to the historical data on which the sampling plans were developed. The accident frequencies by time of day are contained in Table A-25.

TABLE A-24. - BIOTECHNOLOGY BASE RATE ACCIDENT TIME DISTRIBUTIONS

	Phase I		Phase II		Total	
Time of Day	N	%	N	%	N	%
0000 - 0600	58	5.4	43	6.3	101	5.7
0600 - 1200	179	16.7	146	21.3	325	18.5
1200 - 1800	499	46.6	283	41.2	782	44.5
1800 - 2400	334	31.2	215	31.3	549	31.2
Unknown	31	--	22	--	53	--
TOTAL	1101	100.0	709	100.0	1810	100.0

TABLE A-25. - WEIGHTED DISTRIBUTION OF ACCIDENT TIME OF CASE INVESTIGATED BY BIOTECHNOLOGY

	Phase I		Phase II		Total	
Time of Day	N	%	N	%	N	%
0000 - 0600	14	2.2	19	3.8	33	2.9
0600 - 1200	98	15.4	79	15.8	177	15.6
1200 - 1800	361	56.9	228	45.6	589	51.9
1800 - 2400	162	25.5	174	34.8	336	29.6
TOTAL	635	100.0	500	100.0	1,135	100.0

There is also a difference in the time distributions for the two phases in the data obtained in investigations by BioTechnology. In this case, however, the difference involves the afternoon and evening time intervals. Again, there is no apparent rationale for the variations. The second data collection phase did concentrate on accidents occurring on the 1300 - 2100 hours time shift, but since the data were adjusted for sampling, this modification should not be reflected.

In any event, the combined distributions from the base rate and observed data sets compare favorably. The goodness-of-fit test results in a X^2 of 35.6 ($p \leq .005$, 3 d.f.), but the coefficient of contingency is 0.18, which is not sufficiently large so that the difference is to be considered meaningful.

Tables A-26 and A-27 present the base rate and observed distributions for the day of the week the accidents occurred.

TABLE A-26. - BASE RATE DAY OF WEEK FREQUENCY DISTRIBUTIONS (BIOTECHNOLOGY)

	Phase I		Phase II		Total	
Day of Week	N	%	N	%	N	%
Sunday	98	8.9	81	11.4	179	9.9
Monday	124	11.3	92	13.0	216	11.9
Tuesday	160	14.5	112	15.8	272	15.0
Wednesday	178	16.2	115	16.2	293	16.2
Thursday	179	16.3	95	13.4	274	15.1
Friday	199	18.1	108	15.2	307	17.0
Saturday	163	14.8	106	15.0	269	14.9
TOTAL	1101	100.0	709	100.0	1810	100.0

TABLE A-27. - WEIGHTED DAY OF THE WEEK TABULATION (BIOTECHNOLOGY)

	Phase I		Phase II		Total	
Day of Week	N	%	N	%	N	%
Sunday	57	9.0	53	10.6	110	9.7
Monday	70	11.0	70	14.0	140	12.3
Tuesday	80	12.6	84	16.8	164	14.4
Wednesday	109	17.1	79	15.8	188	16.5
Thursday	100	15.7	42	8.4	142	12.5
Friday	132	20.8	117	23.4	249	21.9
Saturday	88	13.8	56	11.2	144	12.7
TOTAL	636	100.0	501	100.0	1,137	100.0

In both of the above tables, there do appear to be some differences in the frequency of the days on which accidents occurred between Phases I and II. Since no reason could be identified for the variation, it was believed that the distributions could be combined; thus the differences were essentially attributed to random error.

No meaningful differences could be detected between the base rate and observed frequency distributions ($X_6^2 = 25.6$; $p \leq 0.001$; $\phi' = 0.15$). Note, however, the large overrepresentation (relative to the base rate information) of Friday accidents. In both phases of data collection, the proportion of Friday pedestrian involvements was almost 8 percent of the overall base rate figure.

Finally, the distribution of the accidents by month and year are given in Tables A-28 and A-29.

A goodness-of-fit test proved to be statistically significant ($X_{11}^2 = 31.7$, $p \leq .001$), and the coefficient of contingency was marginally significant ($\phi' = 0.23$).

TABLE A-28. - MONTH BY YEAR ACCIDENT FREQUENCY (BIOTECHNOLOGY BASE RATE DATA)

Month	1978	1979	Average	%
January		75	75	7.1
February		72	72	6.9
March		114	114	10.8
April	105*	94	94	8.9
May	134	99	117	11.1
June	90	57	74	7.0
July	85	77	81	7.7
August	71	94	83	7.9
September	69	84	77	7.3
October	86	88	87	8.3
November	58	89	74	7.0
December	103	67*	103	9.8
TOTAL	801	1010	1051	100.0

*Partial month - not included in average calculation

TABLE A-29. - FIELD INVESTIGATED CASE FREQUENCY BY YEAR AND MONTH (BIOTECHNOLOGY) (WEIGHTED)

Month	1978	1979	Average	%
January		27	27	4.4
February		35	35	5.7
March		70	70	11.3
April	75*	41	41	6.6
May	62	60	61	9.9
June	27	54	41	6.6
July	31	57	44	7.1
August	27	77	52	8.4
September	72	51	62	10.0
October	41	82	62	10.0
November	68	60	64	10.4
December	58	59*	58	9.4
TOTAL	461	673	617	100.0

*Partial month - not included in average computation

Comparison of Accident Variables to Base Rate Data

In the previous subsections, a number of small, hopefully meaningless differences between the base rate data and that gathered through investigations by the teams were noted. The effects of these variations, while expected to be negligible, must be examined. Accordingly, the base rate data file contains a number of accident variables which can be compared directly with data elements in the Pedestrian Accident Data Base. Since the variables selected for inclusion in the base rate data had to be common to all police report forms in the data collection areas, the number of variables were necessarily limited. It should also be noted that there may be slight inter-agency coding rule variations as well as definitional differences between the police agencies and PICS.

The first variable to be investigated is the type of impact, i.e., front, side, or rear. Table A-30 contains the base rate tabulation for this variable and the weighted observed frequencies for the corresponding categories.*

TABLE A-30. - BASE RATE AND WEIGHTED IMPACT TYPE FREQUENCY DISTRIBUTIONS

	Base Rate		Weighted	
Type of Impact	N	%	N	%
Front, Corner	6,101	76.6	3,783	72.7
Side	1,325	16.6	1,248	24.0
Rear	394	5.0	89	1.7
Undercarriage	145	1.8	83	1.6
Unknown	380	---	111	---
TOTAL	8,345	100.0	5,314	100.0

*These are based on the vehicle-pedestrian interaction variable.

There appears to be more rear-end and frontal impacts (with a corresponding decrease in side contacts) in the base rate data than was observed in the data collected in the investigation. This is confirmed, in part, by a X^2 goodness-of-fit statistic of 295.1 ($p \leq 0.001$; 3 d.f.). The associated ϕ' value is 0.24. This is in the "borderline region" where the differences are too large to be disregarded, but perhaps not quite big enough to be of practical significance. However, it is conjectured that much of this variation can be attributed to the fact that any pedestrian accident was included in the base rate data; for inclusion into the Pedestrian Accident Data Base, a pedestrian accident could not have taken place in a parking lot, driveway, etc. Assuming that parking lot or driveway accidents would primarily involve frontal or rear-end impacts, it would seem that the observed data set is representative of the "on-road" pedestrian accidents within the general accident population.

The type of vehicle involved in pedestrian accidents is presented in Table A-31. Since accidents involving trucks were not considered applicable in the data collection process, their frequency is shown but not included in the analysis. The observed data is similar to Table 3-29, but some of the categories have been grouped so that they are consistent with the categories used in the base rate data file.

TABLE A-31. - BASE RATE AND WEIGHTED FREQUENCIES BY VEHICLE TYPE

	Base Rate		Weighted	
Vehicle Type	N	%	N	%
Passenger Car	6,489	91.3	4,517	89.1
Pick-up	475	6.7	372	7.3
Van	142	2.0	180	3.6
Truck	279	---	---	---
Other, Unknown	960	---	82	---
TOTAL	8,345	100.0	5,151	100.0

There is a statistically significant difference between the two distributions ($X_2^2 = 66.7$; $p \leq 0.001$), but since the ϕ' value is 0.11, it is not considered to be meaningful. Furthermore, over 11% of the vehicle types in the base rate data file were "Other" or "Unknown". Knowledge of these could change the results of the comparison. In any event, the vast majority of vehicles in both files are passenger vehicles.

Three variables are contained in the base rate data which can be used to validate that the investigated pedestrian accidents occurred under conditions representative of the general accident population. The variables are the existence of an intersection at the accident site, the weather-related condition of the road, and the pedestrian's action just prior to the impact.

The intersection-relatedness of the accidents is presented in Table A-32. The observed data frequencies are obtained by appropriately grouping the categories in Table 3-12.

TABLE A-32. - INTERSECTION-RELATEDNESS OF BASE RATE AND WEIGHTED DATA

	Base Rate		Weighted	
Intersection	N	%	N	%
Yes	3,289	40.1	2,685	52.8
No	4,922	59.9	2,402	47.2
Unknown	134	---	1	---
TOTAL	8,345	100.0	5,088	100.0

The coefficient of contingency is marginally high to indicate a condition of meaningful difference between the two distributions ($X_1^2 = 340.6$, $p \leq 0.001$, $\phi' = 0.26$). There were obviously more intersection accidents in the accidents investigated by the teams. It is believed that this can be attributed to the inclusion of "off-road" accidents in the base rate sample.

Table A-33 is a tabulation of the road conditions at the time the accident occurred (see also Table 3-15, Section 3).

TABLE A-33. - ROAD CONDITIONS AT TIME OF ACCIDENT - BASE RATE AND WEIGHTED FREQUENCIES

Road Surface Condition	Base Rate N	Base Rate %	Weighted N	Weighted %
Dry	6,685	82.0	4,345	85.4
Wet	1,184	14.5	662	13.0
Snow/Ice/Slush	272	3.3	74	1.5
Other	14	0.2	7	0.1
Unknown	190	---	0	---
TOTAL	8,345	100.0	5,088	100.0

The two distributions appear to be reasonably equivalent; a goodness-of-fit test shows them to be slightly dissimilar, but the difference is practically negligible ($X_3^2 = 68.4$; $p \leq 0.001$; $\phi' = 0.12$). Note that what difference there is can be attributed to an overrepresentation of wet or wintry conditions in the base rate data. It is believed that a number of these accidents were not severe enough to be reported immediately to the authorities and would therefore not be investigated by the teams. In addition, off-road accidents might comprise a significant proportion of these "poor" road condition accidents.

The last "accident condition" variable to be examined is the pedestrian action code. It should be remembered in looking at these distributions that this is a relatively complex variable, which can have slightly different interpretations for the individual codes and at the same time, is dependent on the investigating individual's judgment. The data are presented in Table A-34.

TABLE A-34. - PEDESTRIAN ACTION FREQUENCY DISTRIBUTIONS - BASE RATE AND WEIGHTED DATA

	Base Rate		Weighted	
Pedestrian Activity	N	%	N	%
Crossing	5863	78.1	4,533	87.5
School Bus Related	4	0.1	17	0.3
Other Vehicle Related	62	0.8	162	3.1
Working on Another Vehicle	40	0.5	31	0.6
Working in Roadway	40	0.5	139	2.7
Playing in Roadway	145	1.9	97	1.9
Other	1354	18.0	202	3.9
Not in Roadway	650	--	--	--
Unknown	187	--	133	--
TOTAL	8345	100.0	5,314	100.0

Clearly, there is not a high degree of agreement between the two distributions ($X_6^2 = 1503.2$; $p \leq 0.001$, $\phi' = 0.54$). There is, however, a very large proportion of "other" responses in the base rate data. This may be indicative of the situation in which the investigating officer could not find a coding alternative that fit exactly and rather than selecting the most applicable code, opted for "other". It is also likely that some of the detailed information in the PICS program was not matched perfectly with the police categories and interpretations. The relative proportions are reasonably close, and it is felt that any actual differences are, at worst, minimal. Note also that at least 650 (7.8%) of the base rate cases occurred off the road.

Finally, the base rate data are compared to the observed data on the basis of two characteristics of the involved pedestrian - age and sex. Table A-35 contains the distributions of the pedestrian sex variable.

TABLE A-35. - BASE RATE AND WEIGHTED PEDESTRIAN SEX

Sex	Base Rate N	Base Rate %	Weighted N	Weighted %
Male	5141	62.1	3,089	58.8
Female	3136	37.9	2,163	41.2
Unknown	68	--	0	--
TOTAL	8345	100.0	5,252	100.0

There is very litte difference in the involvement by sex variable ($X_1^2 = 24.1$; $p \leq 0.001$; $\phi' = 0.07$). In both data sets, males are struck about 50% more often than females.

The pattern of involvement by the age of the pedestrian is shown in Table A-36.

There is a rather obvious difference between the age distributions, ($X_{17}^2 = 1303.2$, $p \leq 0.001$, $\phi' = 0.50$). This is sufficiently large so that the median age in the base rate data is 23 years, as opposed to 16 in the observed data. It is postulated that this effect is the cumulative result of the minor differences found in the time-related variables which were discussed in Sections 4-2 through 4-6. The data collection plans emphasized those hours that young children would be subjected to the most exposure to pedestrian accidents.

The major effect of the difference in pedestrian age is to over-emphasize any specific contribution of young children (particularly those under six years old). While this may not be especially desirable from all points of view, there are benefits of this overrepresentation. Pedestrian accidents involving the younger children are, in many ways, special cases of the general problem. There would be little difficulty in making general statements concerning the injury mechanisms, for instance, which affect adults based on data gathered from accidents to persons in their late teens.

There is, however, no group from which inferences can be made about young children. If the frequency of data collected for these young children had been equivalent to that found in the base rate data, there may not have been sufficient volume to thoroughly study any special problems related to children.

TABLE A-36. - PEDESTRIAN AGE DISTRIBUTIONS - WEIGHTED AND BASE RATE

	Base Rate		Weighted	
Pedestrian Age	N	%	N	%
1 - 5	380	4.8	762	14.6
6 - 10	1502	18.9	1,234	23.6
11 - 15	892	11.2	511	9.8
16 - 20	861	10.8	446	8.5
21 - 25	799	10.1	339	6.5
26 - 30	656	8.3	322	6.2
31 - 35	499	6.3	229	4.4
36 - 40	328	4.1	170	3.3
41 - 45	268	3.4	139	2.7
46 - 50	272	3.4	140	2.7
51 - 55	255	3.2	171	3.3
56 - 60	264	3.3	173	3.3
61 - 65	230	2.9	144	2.8
66 - 70	215	2.7	132	2.5
71 - 75	181	2.3	124	2.4
76 - 80	154	1.9	74	1.4
81 - 85	109	1.4	77	1.5
≥ 86	71	0.9	33	0.6
Unknown	409	--	30	--
TOTAL	8345	100.0	5,250	100.0

Summary

In general, there were only minor variations between the base rate data and those data collected by the PICS teams. The most significant of those was, as just described, the fact that the observed data were skewed such that there were more younger pedestrians in the Pedestrian Accident Data Base than in the general accident population.

A second difference existed between the pedestrian actions in the base rate data as compared to the PICS data. This was primarily attributed to coding difficulties and discrepancies.

Lastly, there was a slight variation in the distributions of accident types. It was suggested that this was caused by differences in the definitions of applicable cases; accidents included in the Pedestrian Accident Data Base could not involve parking lots and driveways while the base rate data contained these types of cases.

Nevertheless, it can be concluded that the PICS data base is representative of the population it was intended to sample.

PICS