UM-HSRI-76-12-3
Contract Number DOT-HS-4-00942

A METHODOLOGY FOR DETERMINING THE ROLE OF VEHICLE HANDLING IN ACCIDENT CAUSATION

Appendices B, C, D, E

Duane F. Dunlap
Leonard Segel
Frederick L. Preston
Peter Cooley
Barbara C. Brown

November 1976

Prepared for the Department of Transportation, National Highway Traffic Safety Administration under Contract Number DOT-HS-4-00942. The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UM-HSRI-76-12-3		

4. Title and Subtitle	5. Report Date
A METHODOLOGY FOR DETERMINING THE ROLE OF VEHICLE HANDLING IN ACCIDENT CAUSATION Appendices B, C, D, E	November 1976
	6. Performing Organization Code
7. Author(s) D.F. Dunlap, L. Segel, F.L. Preston, P. Cooley, B.C. Brown	8. Performing Organization Report No. UM-HSRI-76-12-3
9. Performing Organization Name and Address Highway Safety Research Institute The University of Michigan Huron Parkway & Baxter Road Ann Arbor, Michigan 48109	10. Work Unit No. (TRAIS)
	11. Contract or Grant No. DOT-HS-4-00942
	13. Type of Report and Period Covered Final 6/74-4/76
12. Sponsoring Agency Name and Address National Highway Traffic Safety Administration U. S. Department of Transportation Washington, D.C. 20590	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

A review of the literature on the role of vehicle handling in accident causation shows that there has been much conjecture regarding the link between vehicle handling and accidents. Little of a defensible nature is apparent other than vehicle size seems to correlate with accident experience. An examination of available mass accident data also shows this apparent size effect as well as some correlations between (1) vehicle track width and rollover accidents, (2) driver age and size of car, (3) size of car and accidents on curves, and (4) driver age and accidents on curves.

For purposes of the present study, hypotheses were developed linking vehicle handling characteristics to accident descriptors. Careful consideration is then given towards developing a statistical analysis method that would serve to support or negate such hypotheses and which would further define the amount of data required to support a given hypothesis. Implementation of the methodology to investigate the role of vehicle handling, as proposed, requires that four kinds of data be collected: exposure-to-risk data, accident data, vehicle handling descriptors, and "image risk" data. The requirement for each of these data categories is discussed at length. In addition to defining an accident data collection and analysis methodology, efforts were also devoted towards advancing the present state of the art in reconstructing the pre-crash phase of accidents and towards outlining a deterministic analysis procedure for relating vehicle handling performance directly to accident avoidance performance. The conclusions emphasize the formidable and costly nature of implementing the proposed methodology, but point up that by dove-tailing efforts with other areas (of concern to accident causation analysis) agencies could substantially increase the benefit/cost ratio of follow-on research and implementation.

17. Key Words	18. Distribution Statement
Accident Reconstruction, Vehicle Handling, Statistical Analysis, Skid Marks, Vehicle Parameter Data, Accident Data	UNLIMITED

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
NONE	NONE	246	

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

* U. S. GOVERNMENT PRINTING OFFICE : 1973 725-504/328

TABLE OF CONTENTS

APPENDIX B: Analysis of Mass Accident Data for Vehicle Handling Causative Factors. . . . 1

APPENDIX C: Indirect Standardization - An Example. 131

APPENDIX D: Supplemental Accident Report Form for Vehicle Handling. 149

APPENDIX E: Supplemental Data on Relationships Between Vehicle Handling Parameters (and Indices) and Accident Descriptors. . . . 185

APPENDIX B

ANALYSIS OF MASS ACCIDENT DATA FOR VEHICLE HANDLING CAUSATIVE FACTORS

This appendix consists of the detailed tables and figures from whence the broad conclusions in Section 5 were derived. The discussions are of mass accident data from King County (Seattle), Washington and from the State of Texas. Each set of accidents is from 1973 with the data from Texas representing a 5% sample of all the accidents from Texas during that year. Further, each data set was filtered to include only passenger cars, unimpaired drivers, and wet or dry surfaces. The data from King County were further restricted to contain only vehicles involved in single-vehicle accidents, or the striking vehicle in multi-vehicle accidents. The data from Texas consisted only of vehicles involved in single-vehicle accidents.

The specific findings from each of these investigations are discussed next.

B.1 King County (Seattle), Washington Accident Data

Bivariate tables of vehicle types versus several conjectured accident variables were constructed for the King County filtered data set. Two vehicle type variables were used. The vehicle make/model categories are shown in Table B.1, and the vehicle body type categories in Table B.2. Classifications of make/models into body types are given in Table B.3. These two variables were then separately coupled with several other variables to determine their joint influences on the accident record. A listing of the tables that were constructed and an assessment of the utility of the derived information is given in Table B.4.

Table B.1 Vehicle Make/Model - King County Codings

American Motors

Classic, Rebel, Matador
Ambassador
Javelin, Javelin AMX
American, Hornet
Gremlin

Chrysler Corporation

Chrysler - All

Dodge

Coronet, Charger
Polara, Monaco
Challenger
Dart, Swinger, Demon

Imperial - All

Plymouth

Belvedere, Satellite, Sebring, Road Runner, GTX
Fury, Suburban
Barracuda, Grand Coupe
Valiant, Duster

Ford Motor Company

Ford

Fairlane, Torino, Falcon
Custom, Galaxie, XL, LTD, Country Squire, Ranch Wagon
Thunderbird, Landau
Mustang, Mach 1, Grande, Boss
Maverick, Futura
Ranchero
Pinto

Lincoln-Mercury

Montego, Voyager, Villager, Cyclone
Mercury Monterey, Montclair, Park Lane, Marauder,
Marquis, Colony Park

Ford Motor Company (Cont.)

Lincoln-Mercury (Cont.)

Lincoln Continental
Continental Mark III
Cougar
Comet

General Motors Corporation

Buick

Special, Skylark, GS, Sportwagon
LeSabre, Wildcat, Centurion
Electra 225
Riviera

Cadillac

Calais, DeVille, Sixty Special, Brougham
Seventh Five, Limousine
Eldorado

Chevrolet

Chevelle, Malibu, Nomad, Greenbrier
Chevrolet
Biscayne, Bel Air, Impala, Caprice, Brookwood,
Townsman, Kingswood
Camaro
Monte Carlo
Chevy II, Nova, Corvair, Monza
Corvette, Sting Ray
El Camino
Vega

Oldsmobile

F-85, Cutlass, Vista Cruiser, 442
Oldsmobile
Delmont 88, Delta 88, Starfire, Rocket 88, Jetstar
Dynamic 88, Jetstar 88
98
Toronado

Table B.1 (Continued)

General Motors Corporation (Cont.)

Pontiac

Tempest, Lemans, GTO, Safari
Catalina, Executive, Bonneville, Grandville, Brougham, Star Chief
Pontiac, Parisienne
Firebird
Grand Prix
Ventura

Imported Cars

Subaru - All
Triumph - All
Toyota - All
Volvo - All
VW - All
Audi - All
BMW - All
Datsun - All
Dodge Colt

Imported Cars (Cont.)

Fiat 500, 650, 850, 124 Sedans
Ford Anglia, Cortina
Ford Capri
Lotus - All
Mazda - All
Mercedes Benz - All
MG - All
Opel - All
Porsche 911, 912
Porsche 914
Renault - All
Austin - All

Table B.2. Vehicle Body Type

Sub-Compact/Mini

Sub-Compact

Compact

Intermediate

Standard/Full Size

Luxury Sedan

Personal Luxury

European Sports Car

Super Sports

Specialty/Pony

Table B.3. Vehicle Make

Code	Vehicles	INTERMEDIATE
1	AMC Classic, Rebel, Matador	X
2	AMC Ambassador	
4	AMC American, Hornet	
6	AMC Gremlin	
7	Chrysler	
8	Dodge Coronet, Charger	X
9	Dodge Polara, Monaco	
10	Dodge Charger, Challenger	
11	Dodge Dart, Swinger	
13	Plymouth Belvedere, Satellite, GTX	X
14	Plymouth Fury, Suburban	
16	Valiant, Duster	
18	Ford Fairlane, Torino, Falcon	X
19	Ford Custom, Galaxie, Country Squire	
20	Thunderbird, Landau	
21	Mustang, Mach 1, Grande, Boss	
22	Maverick, Futura	
24	Pinto	
25	Mercury Montego, Cyclone, Voyager	X
26	Mercury Monterey, Parklane, Marquis, Colony Park	
29	Cougar	
32	Buick Special, Skylark, Sportwagon	X
33	LeSabre, Wildcat, Centurion	
34	Electra 225	
35	Riviera	
37	Cadillac Calais, DeVille, Brougham	
40	Chevrolet Chevelle, Nomad, Greenbrier	X
41	Bel Air, Impala, Brookwood	
42	Camaro	
44	Chevy II, Nova, Corvair	
47	Vega	
48	Oldsmobile F-85, Cutlass, Vista-Cruiser	X
49	88	
53	Pontiac Tempest, GTO, Safari	X
54	Catalina, Ventura, Bonneville, Granville	
55	Firebird	
63	Toyota Corona, Crown	
69	VW Beetle	
83	Ford Capri	
93	Opel Kadett, 1900, Ralye	
99	Austin Mini, America, 1300, Mini Cooper	

Table B.4. Vehicle Type Bivariate Tables

Code	Name	Code	Name	Utility
49	Vehicle Make/ Model	21	Character of Road	GU
		22	Road Surface	GU
		23	Weather	NUD
		24	Light Conditions	NUD
		26	Type of Accident	U
		31	Vehicle Mix	MU
		51	Vehicle Body Type	U
		52	Vehicle Style	MU
		56	State of Vehicle Registration	NUD
		69	Driver/Vehicle Actions	NUD
		70	Misc. Actions	U
		71	Major Contributing Action	U
		78	Vehicle Defects	NED
		92	No. of Occupants	U
		93	Residence Proximity	MU
		94	Driver Occupation	U
		95	Driver Sex	U
		97	Driver Age-5 yr. Groups	GU
		99	Seat Belt Usage-Driver	U
51	Vehicle Body Type	21	Character of Road	GU
		22	Road Surface	MU
		24	Light Conditions	NUD
		26	Type of Accident	MU
		31	Vehicle Mix	MU
		52	Vehicle Style	MU
		56	State of Vehicle Registration	NUD
		69	Driver/Vehicle Actions	NED
		70	Misc. Actions	MU

Table B.4. (Cont.)

Code	Name	Code	Name	Utility
51	Vehicle Body Type	71	Major Contributing Action	GU
		78	Vehicle Defects	NUD
		92	No. of Occupants	MU
		93	Residence Proximity	MU
		94	Driver Occupation	U
		95	Driver Sex	GU
		97	Driver Age-5 yr. Groups	GU
		99	Seat Belt Usage-Driver	U

KEY:

NED	Not Enough Data
NUD	No Unusual Differences
MU	Marginal Utility
U	Useful Information
GU	Great Utility

In addition to the vehicle type variables, some other combinations of variables were also examined, independent of vehicle type. A listing of the tables constructed for these ancillary variables is given in Table B.5. In the subsections that follow, each of the variables which were coupled with the vehicle type variables are discussed separately. The ancillary variables are discussed next. The bulk of the raw tables constructed in the study are not included but can be made available to those interested.

B.1.1 Vehicle Type Variables. The two vehicle type variables are Vehicle Make/Model and Vehicle Body Type. The joint influence of these variables on the accident record is discussed as follows:

Character of Road

The vehicle body type categories ranked in terms of highest and lowest involvements on curved sections of road are shown in Table B.6. (Make/Model involvements on curves are given in Table 5.2 of Section 5.) It is evident that those vehicles having the highest incidence of accidents on curves are the sporty and subcompact body types. The least involved vehicles are generally in the luxury model class. These findings suggest that either smaller and sporty vehicles and/or people who drive smaller and sporty vehicles are more apt to be involved in accidents on curved sections of road.

Road Surface

The body type categories ranked in terms of highest and lowest involvements on wet surfaces are shown on Table B.7. Similar data for specific Make/Model categories are given on Table 5.6 of Section 5. The data do not show any consistent trends in either Body Type or Make/Model. Specific vehicle make/models vary by as much as 1/3 more or less than the mean of 36% involvement in wet accidents. None, however, with more than 100 accident cases varies by more than 1/4 from the mean. While the most involved

Table B.5. Ancillary Tables

Code	Name	Code	Name	Utility
21	Character of Road	92	No. of Occupants	GU
		94	Driver Occupation	GU
		95	Driver Sex	U
		97	Driver Age-5 yr. Groups	GU
		99	Seat Belt Usage-Driver	GU
		94, 51	Driver Occupation and Vehicle Body Type	GU
		95, 51	Driver Sex and Vehicle Body Type	GU
		99, 49	Seat Belt Usage and Vehicle Make/Model	GU
		99, 51	Seat Belt Usage and Vehicle Make/Model	GU
48	Year of Vehicle	92	No. of Occupants	MU
		94	Driver Occupation	GU
		95	Driver Sex	MU
		97	Driver Age-5 yr. Groups	GU
		99	Seat Belt Usage-Driver	U
97	Driver Age-5 Year Groups	99, 51	Seat Belt Usage and Vehicle Body Type	GU

KEY:

NED	Not Enough Data
NUD	No Unusual Differences
MU	Marginal Utility
U	Useful Information
GU	Great Utility

Table B.6. Percent Accidents on Curved Sections of Road

Vehicle Body Type

Type	% Involvement (N)
European Sports Car	30.3 (132)
Super Sport	22.0 (50)
Sub-Compact/Mini	17.7 (265)
Specialty/Pony	15.9 (718)
Sub-Compact	15.3 (386)
Compact	14.5 (1,158)
Intermediate	11.7 (1,416)
Standard/Full Size	11.2 (2,337)
Personal Luxury	10.9 (192)
Luxury Sedan	10.2 (177)
Total % Involvement	13.5 (9,523)

$$\% = \frac{(100)\ \text{Accidents on Curves for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.7. Percent Accidents on Wet Surfaces.

Vehicle Body Type

Type	% Involvement (N)
European Sports Cars	38.64 (132)
Specialty/Pony	38.58 (718)
Sub-Compact	38.1 (386)
Personal Luxury	38.0 (192)
Intermediate	36.2 (1,416)
Standard/Full Size	35.3 (2,337)
Sub-Compact/Mini	35.2 (1,158)
Sub-Compact	34.3 (265)
Luxury Sedan	31.1 (177)
Super Sport	30.0 (50)
Total % Involvement	35.9 (9,523)

$$\% = \frac{(100)\ \text{Accidents on Wet Surfaces for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

vehicle types are the European sport cars and specialty/pony types, the least involved are the super sport class. These findings do not presently suggest any clear trends toward vehicles which are more heavily involved in wet-surface accidents.

Type of Accident

Forty-four types of accidents are classified in the King County data file. Of these, four types seem to have some relevance to vehicle handling properties: overturning, rear-end, sideswipe, and turning collision accidents.

Overturning accidents are the most recognizable accident type that are associated with vehicle size, or more specifically, track width. The overturning potential of a vehicle is directly related to the ratio of its center-of-gravity height to track width. Since the center of gravity cannot be made any lower than ground clearance and passenger packaging dictates, the major factor which practically determines overturning potential is the track width. In the data shown on Table B.8, the body type categories are ranked in terms of highest and lowest involvements in overturning accidents. Data for specific Make/Model categories are given in Table 5.9 of Section 5. It is immediately evident from Table B.8 that the vehicles showing the highest frequency of rollover accidents are the smaller types, i.e., the ones with the narrowest track width. The implications with respect to specific values of track width and specific makes and models are discussed in Section 5.

Rear-end accidents should provide some idea of the braking performance of specific vehicles. The data for rear-end collisions in the filtered sample for the Seattle data are for vehicles which are the striking vehicle in two- or more-vehicle collisions. Thus, braking performance differences should appear.

Make/model and body type vehicle categories are ranked in terms of highest and lowest involvements in rear-end accidents on Tables B.9 and B.10, respectively. The two most heavily

Table B.8. Percent of Overturning Accidents.

Vehicle Body Type

Type	% Involvement (N)
European Sports Car	6.8 (132)
Sub-Compact/Mini	5.3 (265)
Sub-Compact	3.6 (386)
Compact	3.0 (1,158)
Specialty/Pony	2.2 (718)
Intermediate	1.4 (1,416)
Standard/Full Size	0.7 (2,337)
Luxury Sedan	0.6 (177)
Personal Luxury	0.5 (192)
Super Sport	0.0 (50)
Total % Involvement	2.8 (9,523)

$$\% = \frac{(100)\ \text{Overturning Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.9. Percent Rear-End Accidents

Vehicle Make/Model

Make/Model	% Involvement	(N)
Most Involved		
AMC Gremlin	50	(20)
AMC Ambassador	42	(43)
Vega	39	(152)
Oldsmobile F-85, Cutlass, Vista-Cruiser	39	(153)
Chevrolet Chevelle, Nomad, Greenbrier	38	(235)
Dodge Charger, Challenger	37	(62)
Firebird	37	(60)
Chrysler	36	(126)
Least Involved		
Maverick, Futura	22.5	(289)
Buick Special, Skylark, Sportwagon	23.3	(133)
Plymouth Belvedere, Satellite, GTX	25.6	(156)
Ford Capri	26.2	(61)
Dodge Dart, Swinger	26.6	(177)
AMC American, Hornet	26.9	(67)
Total % Involvement	32.6	(9,523)

$$\% = \frac{(100)\ \text{Rear-End Accidents for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.10. Percent Rear-End Accidents

Vehicle Body Type

Type	% Involvement (N)
Personal Luxury	33.9 (192)
Sub-Compact	33.2 (386)
Intermediate	32.84 (1,416)
Sub-Compact/Mini	32.83 (265)
Standard/Full Size	32.3 (2,337)
Luxury Sedan	32.2 (177)
Specialty/Pony	31.2 (718)
European Sports Car	31.1 (132)
Compact	27.1 (1,158)
Super Sport	16.0 (50)
Total % Involvement	32.6 (9,523)

$$\% = \frac{(100)\ \text{Rear-End Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

involved models are the AMC Gremlin and the AMC Ambassador—albeit each has a low number of total accident involvements. Except for these two, the accident frequencies for the "Most Involved" vehicles are not greatly higher than the rear-end involvement frequency of 32.6% for the total sample. Some of the "Least Involved" vehicles have frequencies substantially less than the total sample; however, the Maverick has a rear-end involvement percentage of almost one-third less than that of the total sample.

Sideswipe and turning collision accident frequencies could indicate the presence (or lack thereof) of side visibility problems in driving a vehicle. Make/model and body type vehicle categories are ranked in terms of highest and lowest involvement frequencies on Tables B.11 and B.12, respectively, for sideswipe accidents and on Tables B.13 and B.14, respectively, for turning collision accidents. In the "Most Involved" class, the Oldsmobile 88; Ford Capri; and Cadillac Calais, DeVille, Brougham show higher than total sample frequencies in both turning collision and sideswipe accidents. There are no common make/models in the "Least Involved" category.

In the body type categories, the least involved vehicles are super sport and European sports car types. In general, however, the findings are mixed. No definite conclusions are apparent.

Vehicle Mix

The "Vehicle Mix" variable refers to the mix of vehicles, objects, pedestrians, etc., that were involved in the collision accident. At this writing, there seems to be little that can be determined from this variable relative to vehicle handling.

Vehicle Body Type - Vehicle Style

The "Vehicle Body Type" classifications are given on Table B.2. The relationship between these and Vehicle Make/Model classifications is shown on Table B.3. It should be kept in mind that these classifications were determined by General Motors Corporation as part of their original work in developing the

Table B.11. Percent Sideswipe Accidents

Vehicle Make/Model

Make/Model	% Involvement	(N)
Most Involved		
Oldsmobile 88	31.0	(58)
Buick Riviera	20.0	(50)
Ford Capri	18.0	(61)
Cougar	18.0	(89)
Cadillac Calais, DeVille, Brougham	18.0	(78)
AMC American, Hornet	17.9	(67)
Ford Fairlane, Torino, Falcon	16.8	(274)
Least Involved		
VW Beetle	4.9	(41)
Toyota Corona, Crown	5.2	(97)
Opel Kadette, 1900, Ralye	7.1	(56)
Mercury Monterey, Parklane, Marquis	8.8	(102)
AMC Classic, Rebel, Matador	9.1	(88)
Buick Special, Skylark, Sportwagon	10.5	(133)
Plymouth Belvedere, Satellite, GTX	10.9	(156)
Total % Involvement	13.4	(9,523)

$$\% = \frac{(100)\ \text{Sideswipe Accidents for a Given Make/Model}}{\text{Total Sideswipe Accidents for a Given Make/Model}}$$

Table B.12. Percent Sideswipe Accidents

Vehicle Body Type

Type	% Involvement (N)
Compact	14.8 (1,158)
Specialty/Pony	14.62 (718)
Personal Luxury	14.58 (192)
Sub-Compact/Mini	14.34 (265)
Sub-Compact	14.25 (386)
Luxury Sedan	13.6 (177)
Intermediate	13.5 (1,416)
Standard/Full Size	8.7 (2,337)
European Sports Car	8.3 (132)
Super Sport	8.0 (50)
Total % Involvement	13.4 (9,523)

$$\% = \frac{(100)\ \text{Sideswipe Accidents for a Given Body Type}}{\text{Total Sideswipe Accidents for a Given Body Type}}$$

Table B.13. Percent Turning Collision Accidents

Vehicle Make/Model

Make/Model	% Involvement	(N)
Most Involved		
Oldsmobile 88	12.1	(58)
Dodge Charger, Challenger	11.3	(62)
Cadillac Calais, DeVille, Brougham	10.3	(78)
Ford Capri	9.8	(61)
Dodge Polara, Monaco	9.8	(82)
Mercury Montego, Cyclone, Voyager	9.6	(52)
Ford Custom, Galaxie, Country Squire	8.6	(525)
Maverick, Futura	8.0	(289)
Least Involved		
Buick Riviera	2.0	(50)
Thunderbird, Landau	2.9	(104)
Camaro	3.0	(135)
Oldsmobile F-85, Cutlass, Vista Cruiser	3.3	(153)
Firebird	3.3	(60)
Vega	3.9	(152)
Dodge Coronet, Charger	4.1	(123)
Total % Involvement	6.2	(9,523)

$$\% = \frac{(100)\ \text{Turning Collision Accidents for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.14. Percent Turning Collision Accidents

Vehicle Body Type

Type	% Involvements (N)
Luxury Sedan	10.2 (177)
Standard/Full Size	6.8 (2,337)
Compact	6.6 (1,158)
Intermediate	6.3 (2,337)
Specialty/Pony	5.71 (718)
Sub-Compact	5.70 (386)
Sub-Compact/Mini	5.3 (265)
Personal Luxury	4.2 (192)
Super Sport	4.0 (50)
European Sports Car	3.0 (132)
Total % Involvement	6.2 (9,523)

$$\% = \frac{(100)\ \text{Turning Collision Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Collision Performance and Injury Report (CPIR) form. The classifications may not be the best for vehicle handling studies. In future work, it seems evident that more refined classes of vehicles will have to be developed.

The distribution of accident frequencies of make/model classes as a function of body style is not shown here due to the bulkiness of the table. An indication of the variability of body types within a given make/model classification can be obtained from Table B.15. This table shows the highest and lowest percentages of accidents involving station wagons among the listed make/models. It is evident that some make/model classes are more homogeneous than others. Again, the need for more refined classes of vehicles is apparent.

Contributing Actions

Actions contributing to an accident are divided into Miscellaneous Actions and Major Contributing Actions in the Seattle data file. Among the miscellaneous actions, skidding accidents provide the most information with respect to vehicle handling considerations. The highest and lowest percentages of skidding accidents for the make/model and body type variables are shown on Tables B.16 and B.17, respectively. It is evident that the super sport and sub-compact/mini type vehicles are the most involved in skidding accidents, while the least involved are the intermediate and luxury models. An exception in the least involved category is the Vega.

Major contributing actions include speeding, following too close, failure to yield, and inattention. The highest and lowest percentages of accidents involving speeding for make/model and body type categories are shown on Tables B.18 and B.19, respectively. Not unexpectedly, the highest involvement in speeding accidents are among the super sport, European sports car, and specialty/pony classes. Somewhat of a surprise, however, is that the leading make/model in speeding accidents is the VW Beetle. Further, it

Table B.15. Percent Accidents Involving Station Wagons Among Make/Model Classes.

Make/Model	% Involvement (N)
Most Station Wagons	
AMC Classic, Rebel, Matador	30 (88)
AMC Ambassador	26 (43)
Plymouth Fury, Suburban	23 (182)
Vega	23 (145)
Oldsmobile F-85, Cutlass, Vista Cruiser	23 (150)
Mercury Monterey, Parklane, Marquis	22 (100)
Pinto	22 (204)
Least Station Wagons	
Mustang, Mach 1, Grande, Boss	0.0 (314)
Thunderbird, Landau	0.0 (101)
Buick LeSabre, Wildcat, Centurion	0.0 (95)
Cougar	0.0 (89)
Cadillac Calais, DeVille, Brougham	0.0 (78)
Dodge Charger, Challenger	0.0 (61)
Total % Involvement	13.6 (9,122)

$$\% = \frac{(100)\ \text{Station Wagon Accidents Within a Given Make/Model Class}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.16. Percent Skidding Accidents

Vehicle Make/Model

Make/Model	% Involvement	(N)
Most Involved		
VW Beetle	39	(41)
Firebird	37	(60)
Camaro	35	(135)
Cougar	34	(89)
Valiant, Duster	32	(188)
Opel Kadette, 1900, Ralye	32	(56)
Mustang, Mach 1, Grande, Boss	32	(327)
Least Involved		
Dodge Polara, Monaco	13.4	(82)
Cadillac Calais, DeVille, Brougham	17.9	(78)
Buick LeSabre, Wildcat, Centurion	18.8	(96)
Dodge Charger, Challenger	19.4	(62)
Vega	20.4	(152)
Chrysler	20.6	(126)
Total % Involvement	28.1	(9,523)

$$\% = \frac{(100)\ \text{Skidding Accidents for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.17. Percent Skidding Accidents

Vehicle Body Type

Type	% Involvement (N)
Super Sport	38.0 (50)
Sub-Compact/Mini	34.7 (265)
European Sport Car	33.3 (132)
Specialty/Pony	32.6 (718)
Compact	29.0 (1,158)
Personal Luxury	27.6 (192)
Sub-Compact	26.5 (386)
Standard/Full Size	26.1 (2,337)
Intermediate	25.8 (1,416)
Luxury Sedan	20.3 (177)
Total % Involvement	28.1 (9,523)

$$\% = \frac{(100)\ \text{Skidding Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.18. Percent Speeding Accidents

Vehicle Make/Model

Make/Model	% Involvement	(N)
Most Involved		
VW Beetle	41	(41)
Plymouth Belvedere, Satellite, GTX	38	(156)
Camaro	37	(135)
Firebird	37	(60)
Opel Kadette, 1900, Ralye	36	(56)
Toyota Corona, Crown	32	(97)
AMC Classic, Rebel, Matador	31	(88)
Least Involved		
Oldsmobile 88	15.5	(58)
Cadillac Calais, DeVille, Brougham	16.7	(78)
Buick Riviera	18.0	(50)
Chrysler	18.3	(126)
AMC Ambassador	18.6	(43)
Dodge Polara, Monaco	19.5	(82)
Dodge Charger, Challenger	21.0	(62)
Total % Involvement	26.8	(9,523)

$$\% = \frac{(100)\ \text{Speeding Accidents for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.19. Percent Speeding Accidents

Vehicle Body Type

Type	% Involvement (N)
Super Sport	44.0 (50)
European Sports Car	36.4 (132)
Specialty/Pony	30.5 (718)
Sub-Compact/Mini	30.2 (265)
Compact	28.7 (1,158)
Intermediate	27.3 (1,416)
Standard/Full Size	26.1 (2,337)
Sub-Compact	23.6 (386)
Personal Luxury	22.9 (192)
Luxury Sedan	20.3 (177)
Total % Involvement	26.8 (9,523)

$$\% = \frac{(100)\ \text{Speeding Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

is interesting to note that four of the make/models most involved in skidding accidents are also most involved in speeding accidents—VW Beetle, Firebird, Camaro, and Opel. The least involved vehicles in speeding accidents are the luxury models.

The trends in following-too-close accidents are not clear. Tables for the most and least involved make/models and body types are given on Tables B.20 and B.21, respectively. It is evident that the over-involved body types are not much more involved than the mean involvement, and that the specific over-involved make/model types represent a mixture of vehicle classes.

Failure-to-yield and inattention accidents are the most common accidents with luxury vehicles. The most and least involved make/models and body types for failure-to-yield accidents are given on Tables B.22 and B.23, respectively. Similar data for inattention accidents are given on Tables B.24 and B.25. One might speculate that a soft ride quality could be a factor in both inattention and failure-to-yield accidents. On the other hand, since luxury vehicles are least involved in speeding and following-too-close accidents, it is necessary that the kind of accidents such vehicles are involved in show up more heavily in other areas. (Again, the percentages shown are based on the total number of accidents of a particular vehicle or class. Thus, if 10% of a vehicle's accidents involve speeding, the other 90% must be allocated to other kinds of accidents. The percentages given, therefore, do not give an absolute picture as to how the accident experience of a particular vehicle compares with other vehicles. Rather, the picture is that of the distribution of the accidents within a particular vehicle class. All manner of exposure data would be required to arrive at specific conslusions regarding the absolute accident experience of a particular vehicle. Specific conclusions about the lulling qualities of a soft ride toward precipitating inattention and failure-to-yield accidents should, therefore, be held in abeyance.)

Table B.20. Percent Following-Too-Close Accidents

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
Cadillac Calais, DeVille, Brougham	15.4 (78)
Cougar	13.5 (89)
Plymouth Fury, Suburban	13.0 (185)
Ford Fairlane, Torino, Falcon	12.4 (274)
Dodge Coronet, Charger	12.2 (123)
Chrysler	11.9 (126)
Least Involved	
Dodge Polara, Monaco	1.2 (82)
Mercury Montego, Cyclone, Voyager	1.9 (52)
Buick Special, Skylark, Sportwagon	3.0 (133)
Buick Electra 225	3.6 (55)
Plymouth Belvedere, Satellite, GTX	4.5 (156)
Thunderbird, Landau	4.8 (104)
Total % Involvement	8.0 (9,523)

$$\% = \frac{(100)\ \text{Following-Too-Close Accidents for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.21. Percent Following-Too-Close Accidents

Vehicle Body Type

Type	% Involvement (N)
Sub-Compact	8.8 (386)
Sub-Compact/Mini	8.7 (265)
Standard/Full Size	8.6 (2,337)
Intermediate	8.47 (1,416)
Luxury Sedan	8.47 (177)
Compact	7.60 (1,158)
European Sports Car	7.58 (132)
Specialty/Pony	6.7 (718)
Personal Luxury	5.2 (192)
Super Sport	0.0 (50)
Total % Involvement	8.0 (9,523)

$$\% = \frac{(100)\ \text{Following-Too-Close Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.22. Percent Failure-To-Yield Accidents

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
Thunderbird, Landau	27.9 (104)
Cadillac Calais, DeVille, Brougham	14.1 (78)
AMC Ambassador	11.6 (43)
Opel Kadette, 1900, Ralye	8.9 (56)
Dodge Polara, Monaco	8.5 (82)
Buick Riviera	8.0 (50)
Dodge Dart, Swinger	7.9 (177)
Cougar	7.9 (89)
Least Involved	
AMC American, Hornet	1.5 (67)
Ford Capri	3.3 (61)
Firebird	3.3 (60)
AMC Classic, Rebel, Matador	3.4 (88)
Plymouth Belvedere, Satellite, GTX	3.8 (156)
Mercury Montego, Cyclone, Voyager	3.8 (52)
Total % Involvement	6.0 (9,523)

$$\% = \frac{(100)\ \text{Failure-To-Yield Accidents for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.23. Percent Failure-To-Yield Accidents

Vehicle Body Type

Type	% Involvement (N)
Personal Luxury	11.5 (192)
Luxury Sedan	9.6 (177)
Standard/Full Size	6.3 (2,337)
Compact	6.1 (1,158)
Intermediate	5.72 (1,416)
Sub-Compact	5.70 (386)
Specialty/Pony	5.2 (718)
Sub-Compact/Mini	4.2 (265)
Super Sport	4.0 (50)
European Sports Car	3.0 (132)
Total % Involvement	6.0 (9,523)

$$\% = \frac{(100)\ \text{Failure-To-Yield Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.24. Percent Inattention Accidents

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
Thunderbird, Landau	11.5 (104)
Ford Capri	11.5 (61)
Buick Electra 225	10.9 (55)
Chrysler	10.3 (126)
Cadillac Calais, DeVille, Brougham	10.3 (78)
Mercury Monterey, Parklane, Marquis	9.8 (102)
Least Involved	
Firebird	1.7 (60)
Oldsmobile 88	1.7 (58)
Buick LeSabre, Wildcat, Centurion	2.1 (96)
Pontiac Tempest, GTO, Safari	3.4 (178)
Valiant, Duster	3.7 (188)
Chevrolet Chevelle, Nomad, Greenbrier	3.8 (235)
Total % Involvement	5.9 (9,523)

$$\% = \frac{(100)\ \text{Inattention Accidents for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.25. Percent Inattention Accidents

Vehicle Body Type

Type	% Involvement (N)
Luxury Sedan	10.2 (177)
Personal Luxury	8.3 (192)
European Sports Car	7.6 (132)
Sub-Compact/Mini	6.4 (265)
Compact	6.2 (1,158)
Super Sport	6.00 (50)
Standard/Full Size	5.99 (2,337)
Specialty/Pony	5.7 (718)
Sub-Compact	5.4 (386)
Intermediate	5.2 (1,416)
Total % Involvement	5.9 (9,523)

$$\% = \frac{(100)\ \text{Inattention Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Number of Occupants

The number of occupants in a vehicle can affect both the handling qualities of the vehicle and the attention level of the driver. The highest and lowest percentages of accidents with just one occupant in the vehicle (the driver) are shown on Tables B.26 and B.27, respectively, for make/model and body type classifications. Vehicles having the most accidents with just one occupant are comprised of a mixture of luxury and sub-compact vehicles. Vehicles having the least accident frequencies with just one occupant (i.e., vehicles most frequently involved in accidents with more than one occupant) are the convertible and super sport classes. Significantly, the one vehicle having the lowest frequency of accidents with just one occupant, or the highest frequency with more than one occupant, is the VW Beetle. This finding might suggest a load-related handling problem with the VW. Later findings will show, however, that the VW is primarily driven by younger students and skilled workers in the Seattle area, so that the load-related factors seemingly apparent here must be tempered with exposure considerations (e.g., as a matter of course, is the VW Beetle more frequently driven with more than one occupant in the vehicle than are other vehicles in the Seattle area?). Somewhat surprising (although perhaps not completely unexpected) is the finding that luxury models and station wagons—relatively larger vehicles—are some of the most involved vehicles in accidents with just one occupant.

Residence Proximity

Conceivably, residence proximity has a bearing on accident causation through the familiarity of the driver with the local roads. Make/model and body type classes for the most and least involved vehicles in accidents within 15 miles of the driver's residence are given on Tables B.28 and B.29, respectively. The findings in terms of specific make/model classes show a maximum

Table B.26. Percent Accidents With Just One Occupant.

Vehicle Make/Model

Make/Model	% Involvement (N)
Most One Occupant	
Ford Capri	88.6 (61)
Chevy II, Nova, Corvair	86.2 (246)
Opel Kadette, 1900, Rayle	85.7 (56)
Buick Electra 225	85.4 (55)
Ford Fairlane, Torino, Falcon	84.0 (274)
AMC Ambassador	83.8 (43)
Thunderbird, Landau	83.6 (104)
Least One Occupant	
VW Beetle	65.9 (41)
AMC American, Hornet	71.7 (67)
Pontiac Catalina, Ventura, Bonneville	75.4 (232)
Plymouth Fury, Suburban	76.2 (185)
Plymouth Belvedere, Satellite, GTX	76.3 (156)
Plymouth Valiant, Duster	76.6 (188)
Buick Special, Skylark, Sportwagon	76.7 (133)
Total % Involvement	80.6 (9,523)

$$\% = \frac{(100)\ \text{Accidents with Just One Occupant for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.27. Percent Accidents With Just One Occupant.

Vehicle Body Type

Type	% Involvement (N)
Personal Luxury	83.3 (192)
Sub-Compact	82.1 (386)
Luxury Sedan	81.4 (177)
Specialty/Pony	80.9 (718)
Sub-Compact/Mini	80.8 (265)
European Sports Car	80.3 (132)
Intermediate	79.6 (1,416)
Compact	79.4 (1,158)
Standard/Full Size	78.7 (2,337)
Super Sport	74.0 (50)
Total % Involvement	80.6 (9,523)

$$\% = \frac{(100)\ \text{Accidents With Just One Occupant for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.28. Percent Accidents Within 15 Miles of Residence.

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
AMC Classic, Rebel, Matador	97.8 (88)
Dodge Polara, Monaco	95.1 (82)
VW Beetle	95.1 (41)
Oldsmobile 88	94.9 (58)
Buick Special, Skylark, Sportwagon	94.7 (133)
Cadillac Calais, DeVille, Brougham	93.6 (78)
AMC Ambassador	93.0 (43)
AMC American, Hornet	92.6 (67)
Least Involved	
Buick Riviera	80.0 (50)
Ford Capri	85.3 (61)
Buick Electra 225	85.4 (55)
Thunderbird, Landau	85.6 (104)
Oldsmobile F-85, Cutlass, Vista Cruiser	86.3 (153)
Mercury Montego, Cyclone, Voyager	86.6 (52)
Total % Involvement	89.1 (9,523)

$$\% = \frac{(100)\ \text{Accidents Within 15 Miles of Residence for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.29. Percent Accidents Within 15 Miles of Residence

Vehicle Body Type

Type	% Involvement (N)
Intermediate	91.0 (1,416)
Sub-Compact	90.9 (386)
Compact	90.6 (1,158)
Sub-Compact/Mini	90.2 (265)
Super Sport	90.0 (50)
Standard/Full Size	89.7 (2,337)
Specialty/Pony	89.6 (718)
Luxury Sedan	89.3 (177)
European Sports Car	88.6 (132)
Personal Luxury	86.4 (192)
Total % Involvement	89.1 (9,523)

$$\% = \frac{(100)\ \text{Accidents Within 15 Miles of Residence for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

of 98% involvement in accidents within 15 miles of the residence for the AMC Classic, Rebel, Matador class and a minimum of 80% for the Buick Riviera. When looking at body type classes, however, the maximum involvement is 90.9% for both sub-compacts and intermediates; the minimum involvement is 86.4% for personal luxury vehicles; while the involvement frequency for the total sample is 89.1%. Obviously, the differences from the mean are not great. It is, therefore, difficult to establish any correlation between residence proximity and vehicle classes in accident causation. With exposure data, these conclusions may change.

Driver Occupation

In sorting out the role of vehicle handling in accident causation, a major question that must be answered concerns whether it is the vehicle that causes the accident or the driver who chooses and drives the vehicle. Driver sex, age, and occupation are three of the factors that have been traditionally examined in attempting to answer this question. Driver occupation is discussed here, with sex and age being discussed in the following sections.

Make/model and body type classes for the most and least involved vehicles in accidents with professional people as drivers are given on Tables B.30 and B.31, respectively. Such drivers are most involved in accidents with luxury sedans and super sport classes and least involved with specialty/pony and sub-compacts. The least involved types are not greatly less than the involvement of the total sample, while the most involved types approach almost twice the involvement frequency of the total sample.

Similar rankings for clerical and sales people are shown on Tables B.32 and B.33. These people are more apt to be involved in accidents with sub-compact, sub-compact/mini, and super sport classes of vehicles. The least involvements are with standard and luxury models. Note, however, that the involvement of sub-compact vehicles for this class of drivers is over 50% higher than that of the total sample, while the least involved vehicle types are not

Table B.30. Percent Accidents with Professional People as Driver

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
Cadillac Calais, DeVille, Brougham	15.4 (78)
Buick LeSabre, Wildcat, Centurion	12.5 (96)
Oldsmobile F-85, Cutlass, Vista Cruiser	12.4 (153)
Oldsmobile 88	12.1 (58)
Buick Riviera	12.0 (50)
Chrysler	11.1 (126)
Least Involved	
AMC Ambassador	2.3 (43)
Pontiac Tempest, GTO, Safari	3.9 (178)
Chevy II, Nova, Corvair	4.1 (246)
Camaro	4.4 (135)
VW Beetle	4.9 (41)
Firebird	5.0 (60)
Mustang, Mach 1, Grande, Boss	5.2 (327)
AMC Classic, Rebel, Matador	5.7 (88)
Total % Involvement	8.0 (9,149)

$$\% = \frac{(100)\ \text{Accidents with Professional People as Drivers for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.31. Percent Accidents With Professional People as Drivers

Vehicle Body Type

Type	% Involvement (N)
Luxury Sedan	13.6 (177)
Super Sport	12.0 (50)
Sub-Compact/Mini	8.7 (265)
Personal Luxury	8.33 (192)
European Sports Car	8.33 (132)
Intermediate	7.6 (1,416)
Compact	7.43 (1,158)
Standard/Full Size	7.36 (2,337)
Sub-Compact	6.7 (386)
Specialty/Pony	6.0 (718)
Total % Involvement	7.8 (9,523)

$$\% = \frac{(100)\ \text{Accidents With Professional People as Drivers for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.32. Percent Accidents With Clerical and Sales People as Drivers

Vehicle Make/Model

Make/Model	% Involvement	(N)
Most Involved		
Pinto	35	(214)
Mercury Montego, Cyclone, Voyager	33	(52)
Ford Capri	30	(61)
Toyota Corona, Crown	28	(97)
Vega	26	(153)
Firebird	25	(60)
Opel Kadette, 1900, Rayle	25	(56)
Least Involved		
VW Beetle	12.4	(41)
Dodge Coronet, Charger	13.0	(123)
Dodge Polara, Monaco	14.6	(82)
Plymouth Belvedere, Satellite, GTX	15.4	(156)
Chrysler	15.9	(126)
Buick Riviera	16.0	(50)
Buick Electra 225	16.4	(55)
Total % Involvement	20.1	(9,149)

$$\% = \frac{(100)\text{Accidents with Clerical and Sales People as Drivers for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.33. Percent Accidents With Clerical and Sales People as Drivers.

Vehicle Body Type

Type	% Involvement (N)
Sub-Compact	30.1 (386)
Super Sport	24.0 (50)
Sub-Compact/Mini	23.4 (265)
Specialty/Pony	22.1 (718)
European Sports Car	22.0 (132)
Compact	20.6 (1,158)
Personal Luxury	20.3 (192)
Intermediate	19.7 (1,416)
Luxury Sedan	19.1 (177)
Standard/Full Size	18.0 (2,337)
Total % Involvement	19.6 (9,523)

$$\% = \frac{(100)\text{Accidents With Clerical and Sales People as Drivers for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

appreciably below the total sample frequency. Thus, the preponderance of accidents with sub-compact vehicles is substantially above the other classes of vehicles. (Note also that the number of cases is high, which lends further credence to this finding.)

Least and most involved vehicle rankings for skilled and semi-skilled workers are shown on Tables B.34 and B.35. These people experience almost twice the frequency of the total sample of accidents in super sport type vehicles. Experience in other classes of vehicles is not substantially different from the total sample. It is noteworthy that the highest involvement in accidents for a specific make/model (nearly twice the total sample involvement) is with the VW Beetle.

Rankings for accidents involving housewives and domestics as drivers are shown on Tables B.36 and B.37. It is clearly evident that such drivers are primarily involved in accidents with luxury model vehicles and least involved with the sporty vehicles. There is a suspicion that in two-car families, one car is often a larger luxury model or station wagon which is used for family transportation, while the other is a smaller vehicle used for single-occupant commuting. With children in school and the husband away at work, the larger vehicle is used by the housewives in mid-day transportation. This scenario could account for the indicated accident experience. Exposure data is necessary to confirm such speculations, however.

Vehicles involved least and most in accidents with students and children as drivers are ranked on Tables B.38 and B.39. There is also clear evidence here that the most involved vehicles are the European sports car and sub-compact/mini types. Luxury and muscle car classes are the least involved. As with skilled and semi-skilled workers, the accident involvement frequency for the VW Beetle is almost twice the total sample frequency for student and child drivers.

Table B.34. Percent Accidents with Skilled or Semi-Skilled Workers as Drivers.

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
VW Beetle	29.3 (41)
Camaro	23.7 (135)
Oldsmobile 88	22.4 (58)
Cadillac Calais, DeVille, Brougham	21.8 (78)
Pontiac Tempest, GTO, Safari	20.2 (178)
Cougar	19.1 (89)
Thunderbird, Landau	18.3 (104)
Least Involved	
AMC Ambassador	7.0 (43)
Opel Kadett, 1900, Rayle	10.7 (56)
Buick Electra 225	10.9 (55)
Mustang, Mach 1, Grande, Boss	11.0 (327)
Buick LeSabre, Wildcat, Centurion	11.5 (96)
Buick Riviera	12.0 (50)
Buick Special, Skylark, Sportwagon	12.0 (133)
Total % Involvement	15.0 (9,523)

$$\% = \frac{(100)\text{Accidents With Skilled or Semi-Skilled Workers as Drivers for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.35. Percent Accidents With Skilled or Semi-Skilled Workers as Drivers

Vehicle Body Type

Type	% Involvement (N)
Super Sport	28.0 (50)
Luxury Sedan	17.5 (177)
Sub-Compact/Mini	17.4 (265)
Personal Luxury	16.7 (192)
Specialty/Pony	15.3 (718)
Intermediate	15.0 (1,416)
Standard/Full Size	14.9 (2,337)
Compact	14.7 (1,158)
European Sports Car	14.4 (132)
Sub-Compact	14.3 (386)
Total % Involvement	15.0 (9,523)

$$\% = \frac{(100)\text{Accidents With Skilled or Semi-Skilled Workers as Drivers for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.36. Percent Accidents With Housewives and Domestics as Drivers.

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
Buick Electra 225	20.0 (55)
Buick Special, Skylark, Sportwagon	14.3 (133)
AMC Ambassador	14.0 (43)
Chrysler	13.5 (126)
Mercury Monterey, Parklane, Marquis	12.7 (102)
Cadillac Calais, DeVille, Brougham	11.5 (78)
AMC American, Hornet	10.4 (67)
Least Involved	
Ford Capri	1.6 (61)
Firebird	3.3 (60)
Camaro	3.7 (135)
VW Beetle	4.9 (41)
Plymouth Belvedere, Satellite, GTX	5.1 (156)
Mustang, Mach 1, Grande, Boss	5.2 (327)
Opel Kadett, 1900, Rayle	5.4 (56)
Total % Involvement	7.2 (9,149)

$$\% = \frac{(100)\text{Accidents With Housewives and Domestics as Drivers for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.37. Percent Accidents With Housewives and Domestics as Drivers.

Vehicle Body Type

Type	% Involvement (N)
Luxury Sedan	12.4 (177)
Personal Luxury	8.9 (192)
Compact	8.5 (1,158)
Standard/Full Size	8.4 (2,337)
Intermediate	8.0 (1,416)
Sub-Compact	6.5 (386)
Sub-Compact/Mini	4.91 (265)
Specialty/Pony	4.87 (718)
Super Sport	2.0 (50)
European Sports Car	0.8 (132)
Total % Involvement	7.0 (9,523)

$$\% = \frac{(100)\text{Accidents With Housewives and Domestics as Drivers for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.38. Percent Accidents With Students and Children as Drivers

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
VW Beetle	31.7 (41)
Opel Kadett, 1900, Rayle	30.4 (56)
Toyota Corona, Crown	22.7 (97)
Firebird	21.7 (60)
Mustang, Mach 1, Grande, Boss	20.8 (327)
AMC Classic, Rebel, Matador	20.4 (88)
Dodge Coronet, Charger	19.5 (123)
Least Involved	
Cadillac Calais, DeVille, Brougham	5.1 (78)
Buick Riviera	6.0 (50)
Ford Capri	6.6 (61)
Thunderbird, Landau	6.7 (104)
Chrysler	7.1 (126)
Dodge Charger, Challenger	8.1 (62)
Oldsmobile 88	8.6 (58)
Total % Involvement	16.4 (9,149)

$$\% = \frac{(100)\text{Accidents With Students and Children as Drivers for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.39. Percent Accidents With Students and Children as Drivers

Vehicle Body Type

Type	% Involvement (N)
European Sports Car	27.3 (132)
Sub-Compact/Mini	22.6 (265)
Specialty/Pony	18.8 (718)
Compact	18.3 (1,158)
Intermediate	17.0 (1,416)
Sub-Compact	15.3 (386)
Standard/Full Size	15.0 (2,337)
Luxury Sedan	10.2 (177)
Super Sport	8.0 (50)
Personal Luxury	6.2 (192)
Total % Involvement	15.7 (9,523)

$$\% = \frac{(100)\text{Accidents With Students and Children as Drivers for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

In summary, the highest involved vehicle types by occupation are listed as follows:

Professional	Luxury Sedan Super Sport
Clerical/Sales	Sub-Compact Super Sport
Skilled/Semi-Skilled Workers	Super Sport Luxury Sedan
Housewives/Domestics	Luxury Sedan Personal Luxury
Students/Children	European Sports Car Sub-Compact/Mini

Some caution should be used in interpreting these results in that the accident involvement frequencies may also correlate highly with vehicle selection and usage patterns. Specific conclusions about vehicle handling factors in accident causation can be most readily obtained when accident and usage experience do not correlate.

Driver Sex

There has been much written over the years concerning the different accident patterns among males and females in the driving population. Until a few years ago, the female had definitely been considered to be the safer driver; this conclusion was based on recorded accident frequencies. With the recent acquisition of driver exposure data—albeit limited—a pattern seems to be emerging that suggests fewer differences between the sexes than had been originally thought [127]. Among younger drivers, the female seems to be slightly superior. In middle and older ages, however, the male seems to be slightly superior. Further, it appears that the differences are minor if comparisons are made between male and female drivers who have similar mileage exposure.

Rankings of most involved and least involved vehicle classes with males as drivers are shown on Tables B.40 and B.41. Although it is obvious that certain vehicles experience a high frequency of accidents with male drivers, few clear patterns are apparent, the main exception being the over-involvement of male drivers in the super sport class of vehicles. At the other extreme, male drivers are least involved (or conversely, female drivers are most involved) with sub-compact vehicles. The difference between accident frequencies with the sub-compact (60.7%) and the involvement frequency for the total sample (64.7%) is not great, however.

Driver Age

It is well known that the frequency of accidents for young drivers is the highest for any age segment of the driving population. The lowest accident frequencies occur for drivers in middle age brackets. Accident frequencies are also high for older drivers, but not as high as for younger drivers.

With the expanding population, it is generally true that the number of drivers in a given age bracket decreases with increasing age. That is, there are more drivers between ages 20-24 than there are between ages 50-54. Further, drivers who are killed at a younger age are not part of the driving population in older brackets, and hence there is a trend toward safe drivers in the older age brackets through natural selection. All these factors, and more, must be weighed in determining the influence of driver age on accident experience. For example, if there are more drivers in the younger age brackets, then the accident frequencies of drivers in these brackets must be weighted accordingly so as not to distort the results.

A most important consideration in determining the role of vehicle handling in accident causation relates to the make-up of the driving population which chooses to use particular vehicles. If European sports cars have the highest accident experience and younger drivers most frequently drive European sports cars, it is not immediately clear whether the sports car or the younger driver is at fault, or perhaps some combination.

Table B.40. Percent Accidents With Male Drivers

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
Dodge Polara, Monaco	79 (82)
Dodge Charger, Challenger	77 (62)
Oldsmobile 88	76 (58)
Firebird	73 (60)
Ford Capri	72 (61)
Cadillac Calais, DeVille, Brougham	72 (78)
Least Involved	
AMC Ambassador	49 (43)
Toyota Corona, Crown	50 (97)
Mercury Montego, Cyclone, Voyager	54 (52)
Buick Riviera	54 (50)
VW Beetle	56 (41)
AMC American, Hornet	57 (67)
Dodge Dart, Swinger	57 (177)
Plymouth Valiant, Duster	58 (188)
Vega	58 (152)
Total % Involvement	64.7 (9,523)

$$\% = \frac{(100)\text{Accidents with Male Drivers for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.41. Percent Accidents With Male Drivers

Vehicle Body Type

Type	% Involvement (N)
Super Sport	82.0 (50)
Luxury Sedan	70.1 (177)
Intermediate	67.2 (1,416)
Specialty/Pony	66.4 (718)
European Sports Car	65.9 (132)
Standard/Full Size	65.7 (2,337)
Sub-Compact/Mini	63.4 (265)
Personal Luxury	62.5 (192)
Sub-Compact	60.6 (386)
Compact	57.2 (1,158)
Total % Involvement	64.7 (9,523)

$$\% = \frac{(100)\text{Accidents With Male Drivers for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.42. Mean Driver Age for Vehicle Make/Model Classes

Code	Vehicles	Mean Driver Age
1	AMC Classic, Rebel, Matador	34.9
2	AMC Ambassador	38.6
4	AMC American, Hornet	33.6
6	AMC Gremlin	25.7
7	Chrysler	43.6
8	Dodge Coronet, Charger	29.3
9	Dodge Polara, Monaco	37.8
10	Dodge Charger, Challenger	28.0
11	Dodge Dart, Swinger	33.8
13	Plymouth Belvedere, Satellite, GTX	30.3
14	Plymouth Fury, Suburban	34.7
16	Valiant, Duster	33.8
18	Ford Fairlane, Torino, Falcon	32.2
19	Ford Custom, Galaxie, Country Squire	34.0
20	Thunderbird, Landau	35.1
21	Mustang, Mach 1, Grande, Boss	26.1
22	Maverick, Futura	33.2
24	Pinto	28.4
25	Mercury Montego, Cyclone, Voyager	34.7
26	Mercury Monterey, Parklane, Marquis, Colony Park	37.8
29	Cougar	29.9
32	Buick Special, Skylark, Sportwagon	36.0
33	LeSabre, Wildcat, Centurion	38.9
34	Electra 225	39.3
35	Riviera	37.7
37	Cadillac Calais, DeVille, Brougham	44.3
40	Chevrolet Chevelle, Nomad, Greenbrier	31.0
41	Bel Aire, Impala, Brookwood	32.1
42	Camaro	24.1
44	Chevy II, Nova, Corvair	31.4
47	Vega	26.4
48	Oldsmobile F-85, Cutlass, Vista-Cruiser	35.0
49	88	37.2
53	Pontiac Tempest, GTO, Safari	28.9
54	Catalina, Ventura, Bonneville, Granville	36.3
55	Firebird	24.1
63	Toyota Corona, Crown	27.8
69	VW Beetle	26.6
83	Ford Capri	26.0
93	Opel Kadett, 1900, Ralye	24.6
99	Austin Mini, America, 1300, Mini Cooper	41.0
	Mean Age	32.2

Table B.43. Youngest and Oldest Mean Driver Age Values

Vehicle Make/Model

Make/Model	Mean Driver Age (N)
Youngest	
Firebird	24.07 (60)
Camaro	24.13 (135)
Opel Kadett, 1900, Ralye	24.6 (56)
Ford Capri	26.018 (61)
Mustang, Mach 1, Grande, Boss	26.006 (327)
Vega	26.4 (152)
VW Beetle	26.6 (41)
Oldest	
Cadillac Calais, DeVille, Brougham	44.3 (78)
Chrysler	43.6 (126)
Buick Electra 225	39.3 (55)
Buick LeSabre, Wildcat, Centurion	38.9 (96)
AMC Ambassador	38.6 (43)
Mercury Monterey, Parklane, Marquis	37.83 (102)
Dodge Polara, Monaco	37.75 (82)
Mean Age	32.2

Table B.44. Mean Driver Age Rankings of Accident Involved Vehicle Body Types

Type	Mean Driver Age
European Sports Car	24.6
Specialty/Pony	26.3
Sub-Compact	26.5
Sub-Compact/Mini	27.4
Super Sport	29.0
Intermediate	32.1
Compact	32.2
Standard/Full Size	34.8
Personal Luxury	37.3
Luxury Sedan	41.2
Mean Age	32.2

In summary, then, there is a general pattern of higher frequencies of accidents at younger ages which tapers off to a relatively stable level after age 30. For some classes of vehicles, namely, specialty/pony, super sport, sub-compact, sub-compact/mini, and European sports cars, there is a relative over-involvement of accidents with younger drivers. For others, such as the personal luxury and luxury sedan classes, there is a relative under-involvement. The question which remains to be answered is whether the drivers or the vehicles are the most culpable factor. Answering this question will require a knowledge of the distribution of ages in the driving population in general and for specific vehicle classes in particular.

Seat Belt Usage—Driver

Seat belt usage in the context of vehicle handling was examined because of the speculation that belt usage is an indicator of driver attitudes toward safety, and because it has been conjectured that the stabilizing influence of a seat belt may cause a driver to execute more severe maneuvers (e.g., tighter cornering) than would ordinarily be the case.

The percent usage of seat belts for make/model and body type classes most and least involved in accidents are given on Tables B.45 and B.46, respectively. Indications from the body type classifications are that drivers of smaller vehicles are more likely to be wearing seat belts when involved in accidents than are drivers of larger vehicles. An outstanding exception is the VW Beetle where the usage of seat belts by drivers involved in accidents is less than one-half the average. The question of whether a seat belt stabilizes a driver during a maneuver is treated more specifically in the next section where seat belt usage and accident frequency on curves is examined.

Table B.45. Percent Seat Belt Usage

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
AMC Ambassador	42 (43)
Ford Capri	41 (61)
Vega	40 (152)
Opel Kadett, 1900, Ralye	39 (56)
Toyota Crown, Corona	37 (97)
Dodge Coronet, Charger	37 (123)
Pinto	36 (214)
Least Involved	
VW Beetle	12.2 (41)
Dodge Charger, Challenger	17.8 (62)
Thunderbird, Landau	19.2 (104)
BelAire, Impala, Brookwood	20.9 (881)
Ford Custom, Galaxie, Country Squire	21.2 (525)
Catalina, Ventura, Bonneville, Granville	23.3 (232)
AMC Classic, Rebel, Matador	23.8 (88)
Total % Involvement	26.4 (9,523)

$$\% = \frac{(100)\text{Accidents Where Driver Used Seat Belts for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.46. Percent Seat Belt Usage

Vehicle Body Type

Type	% Involvement (N)
Sub-Compact	37.3 (386)
European Sports Car	34.1 (132)
Sub-Compact/Mini	33.6 (265)
Luxury Sedan	32.8 (177)
Super Sport	32.0 (50)
Intermediate	30.4 (1,416)
Specialty/Pony	30.2 (718)
Compact	28.3 (1,158)
Standard/Full Size	24.2 (2,337)
Personal Luxury	22.4 (192)
Total % Involvement	26.3 (9,523)

$$\% = \frac{(100)\text{Accidents Where Driver Used Seat Belts for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

B.1.2 Ancillary Variables. In addition to the vehicle type variables, the filtered data sample for handling-related accidents was also analyzed for several other variables, independent of vehicle type. A typical example would be the frequency of accidents on curved sections of road as a function of driver occupation. In addition, some tri-variate cases were examined. One of these was concerned with the incidence of accidents on curves for specific combinations of driver occupation and vehicle body type. The combinations of variables which are described next were listed earlier on Table B-5.

Character of Road

The variation of accident frequencies on straight or curved sections of road (Character of Road) were examined in relation to number of vehicle occupants, driver occupation, driver sex, driver age, and seat belt usage.

Table B-47 shows that the frequency of accidents on curved sections of road increases with the number of vehicle occupants. The frequency of accidents with three or four occupants in the vehicle is almost twice that with just one occupant in the vehicle. This finding could either suggest that (1) the driver is less efficient (e.g., distracted) when other passengers are in the vehicle or (2) vehicles with more than one occupant handle less effectively on curves. The latter hypothesis was investigated more thoroughly by examining the prevalence of accidents on curves for specific vehicle make/models and vehicle body types. The results, ranked in terms of most and least involved are given on Tables B.48 and B.49, respectively. It is immediately obvious from these tables that the sub-compact and sporty-type vehicles are the most heavily involved in these kinds of accidents. There seems a good likelihood, then, that accidents occur more frequently on curves when certain types of cars are heavily loaded. As indicated here, the smaller vehicles may be more susceptible to overloading since the occupants in a smaller vehicle represent a greater percentage of the total vehicle weight.

Table B.47. Accidents on Curved and Straight Sections of Road Versus Number of Vehicle Occupants.

No. Occupants	Character of Road				Total (Including Unknown)
	Straight		Curved		
	#	%	#	%	
1	6,765	88	915	12	7,680
2	1,006	81	240	19	1,246
3	285	78	81	22	366
4	123	78	35	22	158
5	48	80	12	20	60
6	8	89	1	11	9
>6	4	100	0	0	4
	8,239	87	1,284	13	9,523

$$\% = \frac{(100)\text{Accidents on Straight or Curved Sections of Road for a Given Number of Occupants}}{\text{Total Accidents for a Given Number of Occupants}}$$

Table B.48. Percent of Total Accidents With More Than One Occupant on Curved Sections of Road

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
VW Beetle	9.8 (41)
Firebird	6.7 (60)
Toyota Corona, Crown	6.2 (97)
Camaro	5.9 (135)
Cougar	5.6 (89)
Buick Special, Skylark, Sportwagon	5.3 (133)
Buick LeSabre, Wildcat, Centurion	5.2 (96)
Least Involved	
Dodge Polara, Monaco	0 (82)
Dodge Charger, Challenger	0 (62)
AMC Ambassador	0 (43)
Vega	1.3 (152)
AMC American, Hornet	1.5 (67)
Buick Electra 225	1.8 (55)
Thunderbird, Landau	1.9 (104)
Mercury Montego, Parklane, Marquis	1.9 (52)

$$\% = \frac{(100)\text{Accidents on Curves With More Than One Occupant for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.49. Percent of Accidents With More Than One Occupant on Curved Sections of Road.

Vehicle Body Type

Type	% Involvement (N)
Super Sport	12.0 (50)
European Sports Car	9.1 (132)
Sub-Compact	5.7 (265)
Specialty/Pony	4.3 (718)
Intermediate	3.7 (1,416)
Compact	3.63 (1,158)
Standard/Full Size	3.59 (2,337)
Sub-Compact/Mini	2.6 (386)
Luxury Sedan	2.3 (177)
Personal Luxury	1.6 (192)

$$\% = \frac{(100)\text{Accidents on Curves With More Than One Occupant for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Accidents on curved and straight sections of road as a function of driver occupation are shown on Table B.50. Individuals most involved in accidents on curves are students and military personnel; the least involved are commercial drivers and housewives. These findings suggest some interesting speculations. On the one hand, the low incidence of accidents with commercial drivers suggests that driving skill is a factor in accident experience on curves. On the other hand, the lower accident experience of housewives (a group not particularly remarkable for driving skill) suggests that caution and prudence may also be important factors in reducing accidents on curves. It may be, however, that housewives are not as exposed to driving on curves in the Seattle area to the extent that the other groups are.

This subject was examined a bit closer by looking at the frequency of accidents on curves as a function of driver occupation and vehicle body type. The most and least involved occupation/body type combinations in accidents on curves are shown on Table B.51. Although military personnel in aggregate have the highest frequency of accidents on curves, none of the individual combinations of military personnel and body type have enough accident cases to draw any specific conclusions. Of the combinations that do have enough cases, it is evident that student/children drivers have the worst record of accidents on curves. These drivers show high accident frequencies with four different vehicle body types. Specialty/pony vehicles show up as the most heavily involved body type for the six "Most Involved" combinations. The least involved vehicles are the standard/full size and intermediate body types, with housewives/domestics and clerical/sales occupations the least involved driver occupations.

These data show that there are certain combinations of driver occupation and vehicle body type that show up more heavily in accidents on curves. A careful analysis of this and other types of accident data (e.g., skidding, speeding, overturning, etc.) could lead to recommendations for matching vehicles to drivers.

Table B.50. Accidents on Curved and Straight Sections of Road Versus Driver Occupation.

Occupation	Character of Road				Total (Including Unknown)
	Straight		Curved		
	#	%	#	%	
Professional	655	89	85	11	740
Farmers, Farm Labor	15	100	0	0	15
Clerical, Sales	1,629	87	235	13	1,864
Commercial Drivers	208	92	17	8	225
Military Personnel	120	79	31	21	151
Skilled, Semi-Skilled	1,256	88	174	12	1,430
Other Workers	767	87	113	13	880
Housewives, Domestics	598	90	64	10	662
Students, Children	1,221	81	282	19	1,503
Police Officers	59	88	8	12	67
	8,239	87	1,284	14	9,523

$$\% = \frac{(100)\text{Accidents on Curves or Straights for a Given Driver Occupation}}{\text{Total Accidents for a Given Driver Occupation}}$$

Table B.51. Percent Accidents on Curves for Specific Driver Occupation/Vehicle Body Type Combinations.

Occupation/Body Type	% Involvement
Most Involved	
Students, Children/Sub-Compact	28.3
Students, Children/Compact	22.6
Students, Children/Specialty-Pony	20.7
Clerical, Sales/Sub-Compact-Mini	17.2
Skilled, Semi-Skilled/Specialty-Pony	16.4
Students, Children/Standard-Full Size	16.2
Least Involved	
Housewives, Domestics/Intermediate	4.4
Commercial Drivers/Standard-Full Size	6.8
Professional/Standard-Full Size	8.1
Clerical, Sales/Intermediate	8.6
Clerical, Sales/Standard-Full Size	9.5
Housewives, Domestics/Standard-Full Size	9.7

$$\% = \frac{(100)\text{Accidents on Curves for Specific Occupation and Body Type}}{\text{Total Accidents for Specific Occupation and Body Type}}$$

Accident frequencies on curves and straight sections of road as a function of driver sex are given on Table B.52. It is apparent that there is a significant difference (less than 0.0000032% chance that the differences represent a random occurrence) between males and females with respect to accidents on curves.

A comparison of the percent accidents on curves, treating combinations of males and females along with particular vehicle body types as groups, is given on Table B.53. In all combinations the percent accidents on curves for females is less than for males. These findings, as indicated earlier for housewives, suggest that females are either less frequently exposed to driving on curves or that they drive with more caution and prudence. In general, vehicle body type appears to be a large factor in accident experience on curves regardless of sex. The smaller, sporty vehicles are obviously more heavily involved than the larger, more conventional types.

Table B.54 shows a frequency of accidents on curved and straight sections of road as a function of driver age. There are clear indications from these data that the frequency of accidents on curves decreases with increasing age. Driver experience, skill, prudence, etc., are apparently important factors.

Seat belt usage as a function of accidents on curves is shown on Table B.55. When seat belts are used, the accident experience is significantly lower (less than 1.4% chance that the differences represent a random occurrence) on curved sections of road. This finding suggests that seat belt usage either (1) improves a driver's ability to negotiate curved sections of road or (2) is consistent with a population of drivers who generally drive more prudently.

An attempt was made to investigate the latter contention by determining the most and least frequently involved combinations of driver age groups and vehicle body types in accidents when seat belts are used. The results are shown on Table B.56. If seat belts <u>do</u> indeed reduce the chance of having an accident, then it

Table B.52. Accidents on Curved and Straight Sections of Road Versus Driver Sex.

Sex	Character of Road				Total (Including Unknown)
	Straight		Curved		
	#	%	#	%	
Male	5,268	86	889	14.4	6,157
Female	2,639	90	306	10.4	2,945
	8,239	87	1,284	13.5	9,523

$$\% = \frac{(100)\text{Accidents on Curves or Straights for a Given Sex}}{\text{Total Accidents for a Given Sex}}$$

Table B.53. Percent Accidents on Curves for Specific Body Types as a Function of Driver Sex.

Body Type	% Males	% Females
Intermediate	12.7	7.5
Standard/Full Size	11.7	8.5
Luxury Sedan	11.3	8.5
Personal Luxury	11.7	9.8
Specialty/Pony	15.5	14.9
Compact	16.9	10.8
Sub-Compact	18.5	15.4
Super Sport	24.4	0.0
Sub-Compact/Mini	20.1	7.0
European Sports Car	32.2	25.6

$$\% = \frac{(100)\text{Accidents on Curves for Specific Sex and Body Type}}{\text{Total Accidents for Specific Sex and Body Type}}$$

Table B.54. Accidents on Curved and Straight Sections of Road Versus Driver Age.

Driver Age	Straight #	Straight %	Curved #	Curved %	Total (Including Unknown)
<15	23	96	1	4	24
15-19	1,552	80	394	20	1,946
20-24	1,520	84	280	16	1,800
25-29	1,023	88	145	12	1,168
30-34	600	87	91	13	691
35-39	468	89	61	11	529
40-44	398	89	49	11	447
45-49	430	91	45	9	475
50-54	397	92	36	8	433
55-64	525	93	37	7	562
>64	331	93	24	7	355
	8,239	87	1,284	13	9,523

$$\% = \frac{(100)\text{Accidents on Curves or Straights for a Given Age}}{\text{Total Accidents for a Given Age}}$$

Table B.55. Accidents on Curved and Straight Sections of Roads Versus Seat Belt Usage.

Seat Belt Usage	Character of Road: Straight #	Straight %	Curved #	Curved %	Total (Including Unknown)
Not Installed	506	80	128	20.2	634
Not Used	2,351	84	438	15.7	2,789
Used	2,169	87	339	13.5	2,508
	8,239	87	1,284	13.5	9,523

$$\% = \frac{(100)\text{Accidents on Curves or Straights for a Given Seat Belt Usage}}{\text{Total Accidents for a Given Seat Belt Usage}}$$

Table B.56. Percent Accidents When Seat Belts are Used for Specific Driver Age/Vehicle Body Type Combinations.

Age/Body Type	% Involvement
Most Involved	
15-19/Sub-Compact-Mini	44.6
40-44/Intermediate	42.7
30-34/Intermediate	42.1
25-29/Sub-Compact-Mini	41.5
35-39/Intermediate	37.2
20-24/Sub-Compact-Mini	37.0
Least Involved	
20-24/Standard-Full Size	18.6
25-29/Standard-Full Size	22.4
15-19/Standard-Full Size	23.1
55-64/Intermediate	23.6
15-19/Compact	24.6
35-39/Standard-Full Size	25.3

$$\% = \frac{(100)\text{Accidents When Seat Belts are Used for Specific Age Group \& Body Type}}{\text{Total Accidents for Specific Age Group \& Body Type}}$$

can be expected that the combinations of driver age and vehicle type having the lowest accident experience when seat belts are used would be the most safely operated vehicles. That is, the absence of accidents with seat belts in a particular combination implies that drivers wearing seat belts are not getting into accidents and these, therefore, are safer drivers. The data on Table B.56 are somewhat surprising in that there is apparently a stronger dependence on vehicle type than on driver age. A dependence on vehicle type would then suggest handling implications. Intermediate and sub-compact/mini's make up all of the most involved combinations, while standard/full size vehicles make up four of the six least involved classes. This finding must be considered tentative, however, since in most age/body type combinations involving the luxury and sporty vehicles there were too few cases to be considered valid for comparison.

The influence of seat belt usage on accidents on curves was also examined by looking at how specific vehicle make/models and body types ranked in such accidents. These rankings were determined by taking the seat belt accidents for each make/model and body type and determining what proportion of these accidents occurred on curves. If seat belt usage has no connection with accidents on curves, then it would be expected that these rankings would be somewhat unordered. Instead, the rankings closely match those for accidents on curves irrespective of the use of seat belts. Table B.57 shows accidents on curves when seat belts are used when compared to accidents with seat belts as a group. The table shows rankings of specific make/models. Table 5.2, repeated from Section 5, is shown next for comparison. Four of the most involved vehicles on Table 5.2 are also most involved with seat belt usage on Table B.57. Similarly, five out of the six least involved vehicles on Table 5.2 are in the least usage category on Table B.57. The same comparisons by body type are shown on Tables B.58 and B.6 (again repeated here). As can be noted, here, the relative rankings are remarkably similar. Both the make/model and body type rankings indicate that seat belt usage is an indicator of driver prudence. Accidents when seat belts

Table B.57. Percent Accidents on Curves When Seat Belts are Used Versus Total Seat Belt Accidents.

Vehicle Make/Model

Make/Model	% Seat Belt Usage
Most Usage	
Toyota Corona, Crown	30.6
Pinto	28.2
Maverick, Futura	19.5
Opel Kadett, 1900, Ralye	18.2
Dodge Charger, Challenger	18.2
Dodge Coronet, Charger	17.4
Least Usage	
AMC Classic, Rebel, Matador	0.0
Thunderbird, Landau	0.0
AMC Ambassador	0.0
VW Beetle	0.0
Cadillac Calais, DeVille, Brougham	3.6
Firebird	5.9
Buick Electra 225	6.3
Vega	6.6

$$\% = \frac{(100)\text{Accidents on Curves When Seat Belts are Used for a Given Make/Model}}{\text{Total Accidents When Seat Belts are Used for a Given Make/Model}}$$

Table 5.2. Percent Accidents on Curved Sections of Road.

Vehicle Make/Model

Make/Model	% Involvement (N)
Most Involved	
Opel Kadett, 1900, Ralye	25.0 (56)
VW Beetle	19.5 (41)
Toyota Corona, Crown	18.6 (97)
Pinto	18.2 (214)
Cougar	18.0 (89)
Dodge Coronet, Charger	17.9 (123)
Least Involved	
AMC Classic, Rebel, Matador	5.7 (88)
AMC Ambassador	7.0 (43)
Chrysler	7.1 (126)
Thunderbird, Landau	7.7 (104)
Cadillac Calais, DeVille, Brougham	7.7 (78)
Buick Electra 225	9.1 (55)
Olds F-85, Cutlass, Vista-Cruiser	9.1 (153)
Total % Involvement	13.5 (9,523)

$$\% = \frac{(100)\text{Accidents on Curves for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.58. Percent Accidents on Curves When Seat Belts are Used Versus Total Seat Belt Accidents.

Vehicle Body Type

Type	% Involvement (N)
European Sports Car	28.9 (45)
Super Sport	25.0 (16)
Sub-Compact	18.8 (144)
Sub-Compact/Mini	15.7 (89)
Compact	14.6 (328)
Specialty/Pony	14.3 (217)
Intermediate	12.1 (431)
Standard/Full Size	11.0 (565)
Luxury Sedan	5.2 (58)
Personal Luxury	4.7 (43)

$$\% = \frac{(100)\text{Accidents on Curves When Seat Belts are Used for a Given Body Type}}{\text{Total Accidents When Seat Belts are Used for a Given Body Type}}$$

Table B.6. Percent Accidents on Curved Sections of Road

Vehicle Body Type

Type	% Involvement (N)
European Sports Car	30.3 (132)
Super Sport	22.0 (50)
Sub-Compact/Mini	17.7 (265)
Specialty/Pony	15.9 (718)
Sub-Compact	15.3 (386)
Compact	14.5 (1,158)
Intermediate	11.7 (1,416)
Standard/Full Size	11.2 (2,337)
Personal Luxury	10.9 (192)
Luxury Sedan	10.2 (177)
Total % Involvement	13.5 (9,523)

$$\% = \frac{(100)\text{Accidents on Curves for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

are used are much less prevalent for vehicles which have a low involvement of accidents on curves, and vice versa. (Keep in mind that the normalizing data base for the percentages on Tables B.57 and B.58 is that of accidents where seat belts are used and not accidents on curves.) Two possible conclusions can be drawn from these findings:

1. Driver/vehicle combinations that are underinvolved in accidents on curves are also underinvolved in accidents on curves when seat belts are used; i.e., fewer accidents occur when seat belts are used. Hence, seat belt usage is an indicator of driver prudence.

2. Driver/vehicle combinations that are overinvolved in accidents on curves are also overinvolved in accidents on curves when seat belts are used, i.e., more accidents occur when seat belts are used. Hence, seat belt usage is an indicator of more risk-taking in curve travel (the driver is more stable in the driver's seat).

These findings might appear to be conflicting but they are not.

Model Year of Vehicle

Vehicle age has been conjectured on many occasions as being a factor in the accident record—primarily as the result of vehicle defects. Vehicle age may be correlated with other factors in the accident record, however, e.g., number of vehicle occupants, driver occupation, driver sex, driver age, and perhaps others. These four are discussed here. Vehicle defects are not discussed, since the reported accident cases where a vehicle defect is listed as a contributing factor are far too small to produce any significant conclusions.

The relationship between the number of vehicle occupants and vehicle model year is shown on Table B.59. There is an indication, although not strong, that the number of vehicles involved in accidents with just one occupant increases as the age of the vehicle decreases. With model year 1967 and earlier, between 76% and 80% of the vehicles involved in accidents had just one occupant; after 1967, the percentage ranged between 81 and 83%.

The relationship between driver occupation and age of vehicle is shown on Table B.60. There are some interesting trends indicated. Those engaged in professional and clerical/sales occupations show an increasing share of the accidents as the model year becomes newer. The trend is the reverse for skilled/semi-skilled workers, other workers, and student/children categories. The trend is relatively constant across model years for military personnel and housewives/domestics. These findings more than likely indicate vehicle usage characteristics among the drivers.

The distribution of accidents for male and female drivers across vehicle model year is shown on Table B.61. Although there are fewer female accidents in the earlier model years, no clear-cut trends are evident.

The relationship between driver age and vehicle model year in accident experience is shown on Table B.62. For drivers between ages 15-19 there is a clear trend of higher accident frequencies with older vehicles. For ages 20-24, accident experience is relatively uniform with vehicle model year. For ages 25-29 and 30-34 there is a clear trend toward more accidents with newer vehicles. The findings are inconclusive for the older age groups. It is evident, then, that the 15-19-year driver age group is unique in experiencing more accidents with older vehicles.

Table B.59. Model Year and Number of Vehicle Occupants.

Year of Vehicle	1		2		3		4		5		6		>6		Total (Incl. Unk.)
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
<64	1,146	76	235	16	77	5	36	2	15	1	3	0	0	0	1,512
64	474	80	81	14	28	5	5	1	4	1	2	0	0	0	594
65	535	77	117	17	26	4	13	2	6	1	1	0	1	0	699
66	616	79	107	14	41	5	19	2	0	0	0	0	1	0	784
67	660	79	134	16	27	3	11	1	5	1	0	0	0	0	837
68	641	83	89	12	22	3	9	1	10	1	1	0	0	0	772
69	708	82	104	12	33	4	17	2	5	1	1	0	0	0	868
70	613	83	81	11	28	4	11	1	4	1	0	0	0	0	737
71	604	83	85	12	26	4	8	1	1	0	0	0	0	0	724
72	813	81	127	13	38	4	22	2	5	0	1	0	1	0	1,007
73	493	83	74	12	18	3	7	1	4	1	0	0	1	0	597
	7,319	80	1,235	14	364	4	158	2	60	1	9	0	4	0	9,149

Table B.60. Accident Frequencies as a Function of Vehicle Model Year and Driver Occupation.

Year of Vehicle	Professionals		Farmers, Farm Labor		Clerical, Sales		Commercial Drivers		Military Personnel		Skilled, Semi-Skilled		Other Workers		Housewives Domestics		Students, Children		Police Officers		Total (Inc. Unk.)
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
<64	66	4	3	0	195	13	35	2	19	1	206	14	197	13	80	5	275	18	1	0	1,512
64	40	7	0	0	80	13	19	3	6	1	109	18	59	10	33	6	105	18	0	0	594
65	40	6	1	0	108	15	10	1	13	2	122	17	68	10	39	6	140	20	3	0	699
66	67	9	0	0	140	18	15	2	10	1	115	15	66	8	79	10	130	17	5	1	784
67	62	7	2	0	156	19	14	2	15	2	132	16	75	9	75	9	151	18	1	0	837
68	65	8	1	0	161	21	19	2	11	1	132	17	74	10	73	9	127	16	2	0	772
69	73	8	1	0	179	21	33	4	13	1	146	17	72	8	62	7	154	18	1	0	868
70	85	12	4	1	168	23	18	2	15	2	108	15	68	9	49	7	116	16	5	1	737
71	77	11	2	0	178	25	22	3	15	2	110	15	56	8	59	8	92	13	13	2	724
72	96	10	1	0	282	28	22	2	19	2	152	15	90	9	59	6	131	13	18	2	1,007
73	57	10	0	0	186	31	12	2	18	3	81	14	42	7	46	8	59	10	18	3	597
	731	8	15	0	1,838	20	220	2	150	2	1,415	15	868	9	655	7	1,481	16	67	1	9,149

Table B.61. Accident Frequencies as a Function of Vehicle Model Year and Driver Sex.

Year of Vehicle	Male #	Male %	Female #	Female %	Total (Inc. Unk.)
<64	1,015	67	380	25	1,512
64	393	66	168	28	594
65	465	67	191	27	699
66	492	63	267	34	784
67	543	65	272	32	837
68	470	61	281	36	772
69	562	65	287	33	868
70	461	62	258	35	737
71	463	64	253	35	724
72	659	65	329	33	1,007
73	412	69	174	29	597
	5,950	65	2,863	31	9,149

Table B.62. Accident Frequencies as a Function of Vehicle Model Year and Driver Age.

Year of Vehicle	< 15		15-19		20-24		25-29		30-34		35-39		40-44		45-49		50-54		55-64		> 64		Total (Incl. Unk.)
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%	
<64	7	0	433	29	300	20	157	10	81	5	64	4	41	3	50	3	41	3	71	5	54	4	1,512
64	3	1	157	26	111	19	68	11	34	6	27	5	29	5	22	4	28	5	30	5	29	5	594
65	1	0	186	27	129	18	71	10	43	6	45	6	27	4	26	4	27	4	45	6	25	4	699
66	0	0	171	22	155	20	84	11	64	8	45	6	35	4	34	4	43	5	54	7	32	4	784
67	2	0	185	22	167	20	88	11	65	8	55	7	41	5	48	6	40	5	51	6	41	5	837
68	2	0	151	20	131	17	87	11	65	8	46	6	59	8	42	5	51	7	55	7	30	4	772
69	2	0	169	19	162	19	108	12	66	8	47	5	46	5	52	6	55	6	61	7	30	3	868
70	1	0	130	18	129	17	112	15	56	8	45	6	41	6	48	7	52	7	45	6	31	4	737
71	1	0	107	15	143	20	109	15	58	8	41	6	42	6	52	7	39	5	47	6	34	5	724
72	4	0	147	15	223	22	164	16	88	9	71	7	52	5	67	7	38	4	66	7	27	3	1,007
73	0	0	86	14	123	21	107	18	67	11	37	6	31	5	33	6	19	3	32	5	18	3	597
	23	0	1,924	21	1,775	19	1,158	13	688	8	525	6	444	5	475	5	433	5	558	6	352	4	9,149

B.2 Texas Accident Data

In contrast to data obtained through a broader filter on the Seattle data set, the Texas data discussed here are somewhat limited in the number of specific vehicle variables for which good data are available. After the initial filter described earlier (see the introduction to this appendix) was applied to the Texas State 5% sample file, the case vehicles remaining were found to be coded poorly for many of the variables which appeared to have a bearing on vehicle handling. For example, no information was readily useful from bivariate tables for vehicle make/model or vehicle body type versus degree of road curvature, driver violations in general, major contributive actions, etc. In other cases, the type of information available in the Seattle data set was not coded by the Texas Department of Public Safety, such as Seat Belt Usage, Driver Occupation, Residence Proximity, and reliable information regarding vehicle dynamics (such as skidding). In addition, a number of tables which were originally generated for these analyses are not realistically useful for inclusion at present, given the size of the study data set.

Two types of tables were generated to examine vehicle involvement in various types of accidents—vehicle make/model tables and vehicle body type tables. The method used to rework these tables deserves some attention here.

A recoding of all specific make/model codes selected in the original file was employed to obtain a workable set of codes which represent make/model combinations of the original codes. Several additional make/model codes were added in this process for purposes of comparison with the Seattle data. Using the same body type scheme as the Seattle file contains, another categorization of make/models was generated. Table B.63 lists the full Texas recode format while Table B.64 lists each make/model under its respective body type category.

Table B.63. Texas Codings

Chrysler Corporation

Chrysler

Chrysler, Imperial, Newport,
New Yorker, 300, other

Dodge

Coronet, Charger

Dart, Swinger
Polara, Monaco

Plymouth

Belvedere, Satellite
Fury
Valiant, Duster

Ford Motor Company

Ford

Fairlane, Torino, Falcon
Custom, Galaxie, LTD
Thunderbird, Landau
Mustang
Maverick
Pinto

Mercury - All

General Motors Corporation

Buick

Special, Skylark
LeSabre, Wildcat

Cadillac - All

Chevrolet

Chevelle
Bel Air, Impala
Camaro
Chevy II, Nova
Vega

Oldsmobile

F-85, Cutlass
Delta 88, Delmont 88

Pontiac

Tempest, LeMans, GTO
Catalina, Bonneville

Imported Cars

Toyota Corona, etc.

VW "Beetle"

Opel Kadette, etc.

Table B.64. Vehicle Make/Models According to Vehicle Body Type Categories - Texas Codings.

Subcompact/Mini

Opel Kadette
Volkswagen Bug

Subcompact

Ford Pinto
Renault
Chevrolet Vega

European Sports Car

MG - Other or Unknown

Super Sport

Chevrolet Corvette

Compact

Chevrolet Chevy II
Chevrolet Corvair
Chevrolet Nova
Dodge Dart
Dodge Demon
Dodge Swinger
Ford Maverick
Mercury Comet
Plymouth Duster
Plymouth Valiant
Rambler American

Specialty/Pony

Chevrolet Camaro
Ford Mustang
Mercury Cougar
Plymouth Barracuda
Pontiac Firebird
Rambler Javelin
Dodge Charger

Intermediate

Buick Skylark
Buick Special
Chevrolet Chevelle
Dodge Coronet
Ford Fairlane
Ford Falcon
Ford Torino
Mercury Montego
Oldsmobile Cutlass
Oldsmobile F-85
Oldsmobile 442
Plymouth Belvedere
Plymouth Satellite
Pontiac GTO
Pontiac LeMans
Pontiac Tempest
Rambler Rebel

Full Size

Buick LeSabre
Buick Wildcat
Chevrolet Bel Air
Chevrolet Biscayne
Chevrolet Caprice
Chevrolet Impala
Chrysler Newport
Chrysler New Yorker
Ford Galaxie
Ford LTD
Mercury Marquis
Mercury Montclair
Mercury Monterey
Oldsmobile Delta 88
Oldsmobile Delmont 88
Pontiac Bonneville

Table B.64 (cont.)

Full Size (cont.)

Chrysler 300
Dodge Monaco
Dodge Polara
Ford Custom
Pontiac Catalina
Pontiac Executive (Star Chief)
Rambler Ambassador
Plymouth Fury

Personal Luxury

Buick Riviera
Chrysler Imperial
Ford Thunderbird
Oldsmobile Toronado

Luxury Sedan

Buick Electra
Cadillac DeVille
Cadillac Fleetwood
Cadillac - Other or Unknown
Lincoln Continental
Oldsmobile 98

A list of the tables constructed is given in Table B.65. A discussion of each of the accident variables which was coupled with a vehicle type variable follows next.

Road Surface/Road Alignment

Tables B.66 through B.68 present data for vehicle body type involvements in certain road surface and road alignment situations. (Note that vehicle make/model rankings for alignment and surface situations are given in Tables 5.3 and 5.7, respectively, of Section 5.)

Looking at the data for road alignment in Table B.66, vehicle size may play a role in accident involvement on curved roads. This is not strongly supported by the body type data in Table B.66, but there is somewhat of a trend. These data look very much like their make/model counterparts (see Table 5.3 of Section 5), with the subcompact/minis and the specialty/pony types at the higher end of the involvement rankings and the luxury sedans and personal luxury vehicles at the low involvement end. Vehicle size appears to have an inverse relationship to accident involvement on curved roads, although the subcompact is an exception to the trend.

Table B.67 shows vehicle body types ranked from highest to lowest in accidents on wet roads. The rankings here are somewhat suggestive of those for curved roads in that smaller classes of vehicles are again overinvolved. The ordering of classes is different, however, and in this case the subcompact/mini class is an exception to the rule.

Involvement in accidents on curved wet roads is presented in Table B.68. The body types involved in accidents on wet roads and in accidents on curved roads, as shown in Tables B.66 and B.67 are fairly similar, although there are problems with small data populations for some of the categories. Controlling for the effects of wetness on road alignment, as shown in Table B.68, there is a trend in the data toward poorer performance of smaller cars on curved roads. Body types in the smaller ranges are at the top of the involvement

Table B.65. Texas Tables

Code	Name	Code	Name
59	Vehicle Make/Model	14	Road Surface
		18	Road Alignment
		19	Accident Type
		71	Driver Sex
		14, 19	Road Surface and Accident Type
	Vehicle Body Type	14	Road Surface
		18	Road Alignment
		19	Accident Type
		66	Driver Age
		71	Driver Sex
		14, 18	Road Surface and Road Alignment
		14, 66	Road Surface and Driver Sex
		18, 66	Road Alignment and Driver Sex
		71, 66	Driver Age and Driver Sex
66	Driver Age	14	Road Surface
		71	Driver Sex

Table B.66. Percent Accidents on Curved Sections of Roads

Vehicle Body Type

Body Type	% Involvement (N)
Subcompact/Mini	25.2 (127)
Specialty/Pony	15.8 (259)
Compact	12.4 (290)
Intermediate	11.9 (572)
European Sports Car	11.1 (9)
Standard/Full Size	9.7 (1085)
Subcompact	8.6 (81)
Super Sport	6.7 (15)
Luxury Sedan	5.9 (119)
Personal Luxury	1.8 (57)
Total % Involvement	11.5 (2,695)

$$\% = \frac{(100)\text{Accidents on Curves for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.68. Percent in Accidents on Curved, Wet Roads

Vehicle Body Type

Body Type	% Involvement (N)
Compact	41.7 (36)
Specialty/Pony	36.6 (41)
Subcompact/Mini	34.4 (32)
Intermediate	30.9 (68)
Standard/Full Size	29.5 (105)
Subcompact	28.6 (7)
Luxury Sedan	14.3 (7)
Personal Luxury	0.0 (1)
Super Sport	0.0 (1)
European Sports Car	0.0 (1)
Total % Involvement	31.8 (311)

$$\% = \frac{(100)\text{Accidents on Curved, Wet Roads for a Given Body Type}}{\text{Total Accidents on Curved Roads for a Given Body Type}}$$

rankings. This fact lends further credence to the speculation that there is a relationship between vehicle size and accident involvement on curved or wet roads. Again, the data are not large enough to draw conclusive inferences, but the scraps of evidence available are suggestive of a trend. Specific data for vehicle make/models are not presented along with Table B.68, because there are not sufficient numbers of data in the curved, wet category of accidents.

Accident Type

In order to further explore the specific involvements of certain make/model and body type categories, it was necessary to take a closer look at the type of accidents in which the case study vehicles were involved. Tables B.69 through B.74 present data for out-of-control, overturned-in-road, and parked-car collisions. The Opel Kadette, usually found as most involved in previous tables, appears as the least involved vehicle make/model, despite a small total number of cases, in out-of-control accidents (Table B.69). In Table B.69, the Toyota Corona is a fairly solid leader for out-of-control accidents. Looking at body type for these same accidents (Table B.70), and removing European sports cars because of population size, there is again some movement in the direction of larger vehicles being less involved in out-of-control accidents.

Table B.71 shows rankings of vehicle body types in out-of-control accidents on wet roads. Although there are some problems with sample size in some of the categories, there is, nevertheless, virtually no trend in vehicle size in these rankings.

Overturned-in-road accidents are ranked for the several body types on Table B.72. If the European sports car and super sport classes are eliminated for the moment because of a small number of cases, there is a near-perfect small-to-large ordering from high to low involvement in overturned-in-road accidents. It may be noted that the subcompact and subcompact/mini classes have approximately

Table B.69. Percent Out-of-Control Accidents.

Vehicle Make/Model

Most Involved	% Involvement (N)
Toyota Corona, Unk.	41.9 (43)
Ford Pinto	37.0 (46)
Dodge Charger, Coronet	36.4 (66)
Cadillac DeVille	33.3 (21)
VW Beetle	33.1 (118)
Least Involved	
Opel Kadette; Other, Unk.	10.5 (19)
Chrysler Imperial, Newport, New Yorker 300; Other, Unk.	16.0 (50)
Pontiac GTO, LeMans, Tempest	16.2 (74)
Chevrolet Camaro	16.7 (54)
Ford Fairlane, Torino, Falcon	17.7 (29)
Total % Involvement	24.5 (2,622)

$$\% = \frac{(100)\text{Out-of-Control Accidents for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.70. Percent Out-of-Control Accidents

Vehicle Body Type

Body Type	% Involvement (N)
Subcompact	35.8 (81)
Subcompact/Mini	31.5 (127)
Compact	30.3 (290)
Intermediate	27.8 (572)
Specialty/Pony	27.4 (259)
Personal Luxury	22.8 (57)
European Sports Car	22.2 (9)
Standard/Full Size	21.8 (1085)
Super Sport	13.3 (15)
Luxury Sedan	11.8 (119)
Total % Involvement	25.3 (2,695)

$$\% = \frac{(100)\text{Out-of-Control Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.71. Percent Out-of-Control Accidents on Wet Surfaces.

Vehicle Body Type

Body Type	% Involvement (N)
Luxury Sedan	42.9 (14)
Subcompact	41.4 (29)
Specialty/Pony	33.8 (71)
Personal Luxury	30.8 (13)
Compact	23.9 (88)
Standard/Full Size	22.8 (237)
Subcompact/Mini	20.0 (40)
Intermediate	18.2 (159)
European Sports Car	0.0 (2)
Super Sport	0.0 (2)
Total % Involvement	24.3 (683)

$$\% = \frac{(100)\text{Out-of-Control Accidents on Wet Surfaces for a Given Body Type}}{\text{Total Out-of-Control Accidents for a Given Body Type}}$$

Table B.72. Percent Overturned-In-Road Accidents

Vehicle Body Type

Body Type	% Involvement (N)
Subcompact/Mini	12.6 (127)
Subcompact	6.2 (81)
Compact	2.8 (290)
Specialty/Pony	2.7 (259)
Intermediate	1.9 (572)
Standard/Full Size	1.3 (1085)
Luxury Sedan	0.0 (119)
Personal Luxury	0.0 (57)
Super Sport	0.0 (15)
European Sports Car	0.0 (9)
Total % Involvement	2.3 (2,695)

$$\% = \frac{(100)\text{Overturned-in-Road Accidents for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

three and six times the involvement rate of the total vehicle population, respectively. As noted in Section 5, involvements in overturning accidents are highly correlated with vehicle track width.

Parked-car involvements are presented in Tables B.73 and B.74. Full-sized vehicles are represented in the most involved make/model category, but it is the body type variable (Table B.74) that shows that the larger vehicles are more involved in parked-car collisions. Perhaps the sheer bulk of the larger vehicles plays a role in the tendency of these vehicles to collide with parked cars.

Driver Sex

Several tables were generated for these analyses, which were also controlled for driver sex, and nearly all of these—driver violation variables, pre-crash maneuver variables, etc.—were useless because of the small size of the resulting data set. A general distribution for driver sex, however, is presented in Tables B.75 and B.76, again by make/model and by body type, respectively.

The Ford Pinto and the Oldsmobile Delta 88, Delmont 88 make/models are the most involved and least involved, respectively, in accidents with male drivers. The super sport and luxury sedan classes are the most- and least-involved body types, respectively, but in general, no trends can be observed here, just as a quick look at the driver sex tables, not included in this report, seemed to indicate. It is interesting, though, that three out of the four most involved types are in the "sporty" category. Keeping in mind that there are not enough data on the car population of each body type to determine its relative exposure to such factors as sex, road type, etc., and thus lay a sound foundation for the following conclusion, it can be seen from Table B.77 that the proportion of

Table B.73. Percent Collisions with Parked Cars

Vehicle Make/Model

Most Involved	% Involvement (N)
Buick Skylark	38.2 (34)
Ford Custom, Galaxie, LTD	36.3 (234)
Ford Thunderbird, Landau	36.0 (25)
Chevrolet Bel Air, Impala	34.9 (393)
Chrysler	32.0 (50)
Least Involved	
Toyota Corona, Unk.	14.0 (43)
Plymouth Belvedere, Satellite	14.7 (34)
Plymouth Duster, Valiant	14.8 (54)
Chevrolet Vega	16.1 (31)
VW Beetle	17.8 (118)
Total % Involvement	30.4 (2,622)

$$\% = \frac{(100)\text{Collisions with Parked Cars for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.74. Percent Collisions with Parked Cars

Vehicle Body Type

Body Type	% Involvement (N)
Luxury Sedan	43.7 (119)
Standard/Full Size	33.7 (1085)
European Sports Car	33.3 (9)
Personal Luxury	31.6 (57)
Intermediate	28.8 (572)
Specialty/Pony	25.1 (259)
Compact	23.4 (290)
Subcompact/Mini	20.5 (127)
Subcompact	17.3 (81)
Super Sport	13.3 (15)
Total % Involvement	29.4 (2,695)

$$\% = \frac{(100)\text{Collisions with Parked Cars for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.75. Percent Accidents with Male Drivers

Vehicle Make/Model

Most Involved	% Involvement (N)
Ford Pinto	86.4 (22)
Oldsmobile Cutlass, F-85	85.9 (78)
Plymouth Belvedere, Satellite	84.4 (32)
Chevrolet; Other, Unk.	79.2 (106)
Plymouth Duster, Valiant	78.4 (51)
Least Involved	
Oldsmobile Delta 88, Delmont 88	34.5 (55)
Ford Maverick	50.0 (62)
Cadillac DeVille	50.0 (20)
Buick Skylark, Special	51.5 (33)
Toyota Corona, Unk.	52.4 (42)
Ford LTD	53.7 (67)
Total % Involvement	70.4 (2,467)

$$\% = \frac{(100)\text{Accidents with Male Drivers for a Given Make/Model}}{\text{Total Accidents for a Given Make/Model}}$$

Table B.76. Percent Accidents with Male Drivers

Vehicle Body Type

Body Type	% Involvement (N)
Super Sport	93.3 (15)
European Sports Car	88.9 (9)
Personal Luxury	79.2 (53)
Specialty/Pony	75.7 (247)
Intermediate	70.8 (543)
Subcompact	70.0 (80)
Compact	69.8 (281)
Subcompact/Mini	69.7 (119)
Standard/Full Size	66.2 (1032)
Luxury Sedan	64.5 (107)
Total % Involvement	71.6 (2,564)

$$\% = \frac{(100)\ \text{Accidents with Male Drivers for a Given Body Type}}{\text{Total Accidents for a Given Body Type}}$$

Table B.77. Percent Accidents for a Given Sex and Body Type

	N	Males Column %	Females Column %
Subcompact/Mini	119	4.7	4.6
Subcompact	80	3.1	3.6
European Sports Car	9	0.4	0.1
Compact	281	11.0	10.8
Super Sport	15	0.8	0.1
Specialty/Pony	247	10.5	7.7
Intermediate	543	21.6	20.3
Standard/Full Size	1032	38.4	44.5
Personal Luxury	53	2.4	1.4
Luxury Sedan	107	3.9	4.8
Total	2,564	100.0	100.0

$$\% = \frac{(100)\ \text{Accidents for a Given Sex and Body Type}}{\text{Total Accidents for a Given Sex}}$$

male drivers of each body type to the rest of the male driving population involved in accidents is roughly equal to its female counterpart. On the basis of this tenuous observation, apparently sex is not a significant factor in accident causation among the various body types.

Driver Age

Several different presentations of driver age data are given in this section. Table B.78 shows vehicle body types ranked in terms of the lowest mean driver age to the highest. There is a clear indication that younger drivers tend to have accidents in vehicles which are concentrated in the smaller sporty classes, while older drivers have accidents in the larger vehicles.

Table B.79 shows some interesting driver age data for selected data subsets of road surface and driver sex. It will be recalled from the discussions of the King County data that male drivers had a significantly larger proportion of accidents on curves than did female drivers (Table B.53). As noted here in Table B.79, the mean age of male drivers is over three years younger than that for female drivers. This age difference, although the comparison is across two different accident sets, may account for the higher accident experience of males on curves.

In another study of age influences, Table B.80 gives the distribution of mean driver age by body type for dry road surfaces and wet road surfaces. The total means for dry and wet roads indicate that wet-road accidents involve drivers with an average age of almost two years lower than that of drivers in dry-road accidents. Six out of the ten body type classes show this relationship. The exceptions are the intermediate, super sport, and specialty/pony, for which no appreciable age differences exist. European sports cars again are too few to allow any generalization.

Table B.78. Mean Driver Age by Body Type for Accident-Involved Vehicles.

Body Type	N	Mean Driver Age
European Sports Car	9	19.1
Specialty/Pony	245	21.8
Subcompact/Mini	118	22.4
Subcompact	80	24.1
Super Sport	15	24.5
Compact	280	27.0
Intermediate	541	27.5
Standard/Full Size	1010	31.8
Personal Luxury	52	34.7
Luxury Sedan	100	39.8
Total	2,527	28.8

Table B.79. Mean Driver Age by Road Surface and by Driver Sex
(Based on Vehicle Make/Model Data)

Road Surface	N	Mean Driver Age
Dry	2441	29.3
Wet	697	27.4
Driver Sex		
Male	2234	28.0
Female	890	31.2

Table B.80. Mean Driver Age by Body Type Controlling for Road Surface

Body Type	Dry Roads N	Dry Roads %	Dry Roads Mean Driver Age	Wet Roads N	Wet Roads %	Wet Roads Mean Driver Age
Subcompact/Mini	91	4.7	22.8	27	4.7	20.7
Subcompact	54	2.8	24.2	26	4.5	23.8
European Sports Car	6	0.3	18.7	3	0.5	20.0
Compact	206	10.6	27.8	74	12.8	24.7
Super Sport	13	0.7	24.4	2	0.3	25.5
Specialty/Pony	181	9.3	21.6	64	11.1	22.1
Intermediate	417	21.4	27.3	124	21.5	28.0
Standard/Full Size	804	41.2	32.3	206	35.7	29.8
Personal Luxury	41	2.1	35.1	11	1.9	33.0
Luxury Sedan	82	4.2	40.6	18	3.1	36.0
Total	1,950	100.0	29.2	577	100.0	27.3

The same mean driver age data are presented in Table B.81, but controlling here for road alignment. In three out of the ten body type classes, primarily large vehicles—personal luxury, standard/full size, and subcompact/mini (mostly Volkswagens)—drivers are younger on curved roads as compared to those involved in accidents on straight roads. Another four showed no appreciable differences in mean driver age, the smaller vehicles—subcompact, compact, specialty/pony, and intermediate. Luxury sedans offer the only major example (there really wasn't enough data for comparison in the super sport class) where drivers were older in curved-road accidents than on straight-road accidents.

Table B.82 documents mean driver age by body type, controlling for driver sex. The mean ages for males and females are 27.8 and 31.5, respectively. Only in the super sport category are male drivers substantially older than their female counterparts. (The reader is again cautioned to consider the small size of the super sport population.) For personal luxury, luxury sedan, and subcompact/mini classes, there is no appreciable age difference between male and female drivers.

In Table B.83, the individual body type classes are given with ten bracketed age groups for each. By and large, most accident involvement occurs between the ages of 15 and 24, where nearly 55% of all accidents happen. Nearly 75% of all involvements occur with drivers under 35. The only major exceptions are personal luxury and luxury sedan classes. Luxury sedans tend to have a fairly uniform distribution. Personal luxury types peak at the ages of 25-29 and 45-49. Specialty/pony vehicles and European sports cars tend to be overwhelmingly more involved in accidents with drivers under 25, as are, to a lesser extent, compacts, subcompacts, and subcompact/minis. The super sport class has a single peak at ages 25-29.

Table B.81. Mean Driver Age by Body Type Controlling for Road Alignment.

Body Type	Straight Roads N	%	Mean Driver Age	Curved Roads N	%	Mean Driver Age
Subcompact	89	4.0	22.4	29	9.7	22.1
Subcompact/Mini	73	3.3	24.7	7	2.3	18.0
European Sports Car	8	0.4	18.9	1	0.0	21.0
Compact	244	11.0	27.0	36	12.1	27.1
Super Sport	14	0.6	23.7	1	0.0	36.0
Specialty/Pony	204	9.2	21.9	41	13.8	21.2
Intermediate	474	21.3	27.4	67	22.5	27.7
Standard/Full Size	910	40.9	32.3	100	33.6	27.4
Personal Luxury	51	2.3	34.8	1	0.0	26.0
Luxury Sedan	94	4.2	39.4	6	2.0	45.2
Total	2,226	100.0	29.2	298	100.0	26.0

Table B.82. Mean Driver Age by Body Type, Controlling for Driver Sex.

	Male Drivers		Female Drivers	
Body Type	N	Mean Driver Age	N	Mean Driver Age
Subcompact/Mini	82	22.7	36	21.6
Subcompact	56	23.4	24	25.8
European Sports Car	8	19.1	1	19.0
Compact	195	25.7	84	30.0
Super Sport	14	25.1	1	17.0
Specialty/Pony	186	21.2	57	23.9
Intermediate	401	26.8	137	29.6
Standard/Full Size	698	30.4	310	35.0
Personal Luxury	41	34.7	11	34.4
Luxury Sedan	63	39.6	37	40.0
Total	1,801	27.8	716	31.5

Table B.83. Driver Age by Vehicle Body Type

Body Type	N	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-64	65-80
Subcompact/Mini	118	28.1	34.7	15.3	6.8	2.5	0.0	0.8	0.0	0.8	0.0
Subcompact	80	36.3	31.3	16.3	3.8	2.5	1.3	1.3	1.3	2.5	1.3
European Sports Car	9	55.6	44.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Compact	280	39.3	23.2	11.4	3.9	1.4	3.9	5.0	2.5	3.6	3.9
Super Sport	15	13.3	26.7	53.3	0.0	6.7	0.0	0.0	0.0	0.0	0.0
Specialty/Pony	245	50.6	25.7	13.5	3.7	2.0	1.6	0.4	0.4	1.2	0.0
Intermediate	541	37.0	24.2	10.5	6.7	3.5	3.1	3.7	2.0	4.3	3.7
Standard/Full Size	1010	29.8	15.5	9.5	10.0	6.4	6.3	3.9	4.8	7.1	5.2
Personal Luxury	52	13.5	13.5	21.2	9.6	11.5	7.7	13.5	1.9	1.9	5.8
Luxury Sedan	100	12.0	9.0	9.0	13.0	12.0	6.0	10.0	8.0	10.0	10.0
Total	2527	34.0	20.8	11.3	7.7	4.9	4.4	3.9	3.1	4.8	3.9

B.3 Conclusion

Generally, small cars are overinvolved in accidents in which the surrounding conditions deviate from the normal, e.g., curved and wet roads. Small cars are also more involved in accidents involving loss of control, overturning, speeding violations, and with male drivers and younger drivers. To some extent, the sporty cars form an exception to the small car group. Sports cars go out of control less than the remainder of the small cars but more than the large cars; they rank about the same as large cars in cases of overturning; and they take the lead in accidents involving both speeding violations and/or male drivers.

The effect of driver sex in a vehicle handling context is not clear. Female drivers as a group experience significantly fewer accidents on curves than do males. Male drivers involved in accidents average over three years younger in age than do females, however. Further, males tend to be involved in accidents with older, and sporty vehicles, but also larger luxury models. The confounding effects are obviously quite complicated. As a result, no conclusions can be drawn as to why a specific body type is more involved in certain types of accidents while another is less involved. For example, from Table B.66, small cars were found to be overinvolved in accidents on curved roads. But is this because small cars are not built to handle curves as well as large cars, or is it because small cars are driven by younger and possibly more inexperienced drivers who are more likely to commit some error that an older and more experienced driver would not? Further study on a sufficiently large data set is clearly necessary in order to isolate accidents by specific age groups, sex, body types, and other factors.

As in any age-related problem, the question involves not only the actual driver age but also the amount of driving experience that those drivers have. In addition, such effects as driver's

education programs, make/model preferences, family size, and transportation needs often become hidden by simplistic age/accident involvement analyses. Obviously, more detailed data on drivers involved in accidents could yield more precise findings than those obtainable from data currently available.

The data for accident experience across driver age are presented in the form of curves rather than tables, since there is presumably some continuous connection between accident experience and vehicle usage across age brackets (i.e., an ordinal relationship). Figures B.1 and B.2 show the driver age distribution for vehicles in the specialty/pony classes. A high concentration of young drivers is clearly evident. By contrast, Figures B.3 and B.4 show driver age distributions for vehicles in the personal luxury and luxury sedan classes, respectively. Personal luxury car accidents peak between ages 25 and 35, while luxury sedan accidents tend to be relatively uniform with age. (Note that the apparent peak at ages 55-64 for luxury sedans is somewhat distorted, in that the 55-64-year age bracket covers ten years, while the younger age brackets cover five years.)

The sub-compact and sub-compact/mini classes of vehicles (Figures B.5 and B.6, respectively) also show high concentrations of accidents involving young drivers. The percentage of accidents with drivers between 20-24 years for sub-compact/mini vehicles is nearly as high as that for European sports cars.

Moving next to compact and intermediate vehicles (Figures B.7, B.8, and B.9 to B.11, respectively), there is a similar trend from a high frequency of accidents among young drivers to lower frequencies after age 35. (It should be remarked that the data for the intermediate class of vehicles are grouped with the three vehicles with the highest number of accidents plotted on the same figure—Figure B.9. The next three vehicle models in order of numbers of accidents were plotted on Figure B.10, and the three with the lowest numbers of accidents on Figure B.11. Differences in the smoothness of the data across age groups are clearly apparent in looking progressively from Figure B.9 through Figure B.10 and then at Figure B.11.)

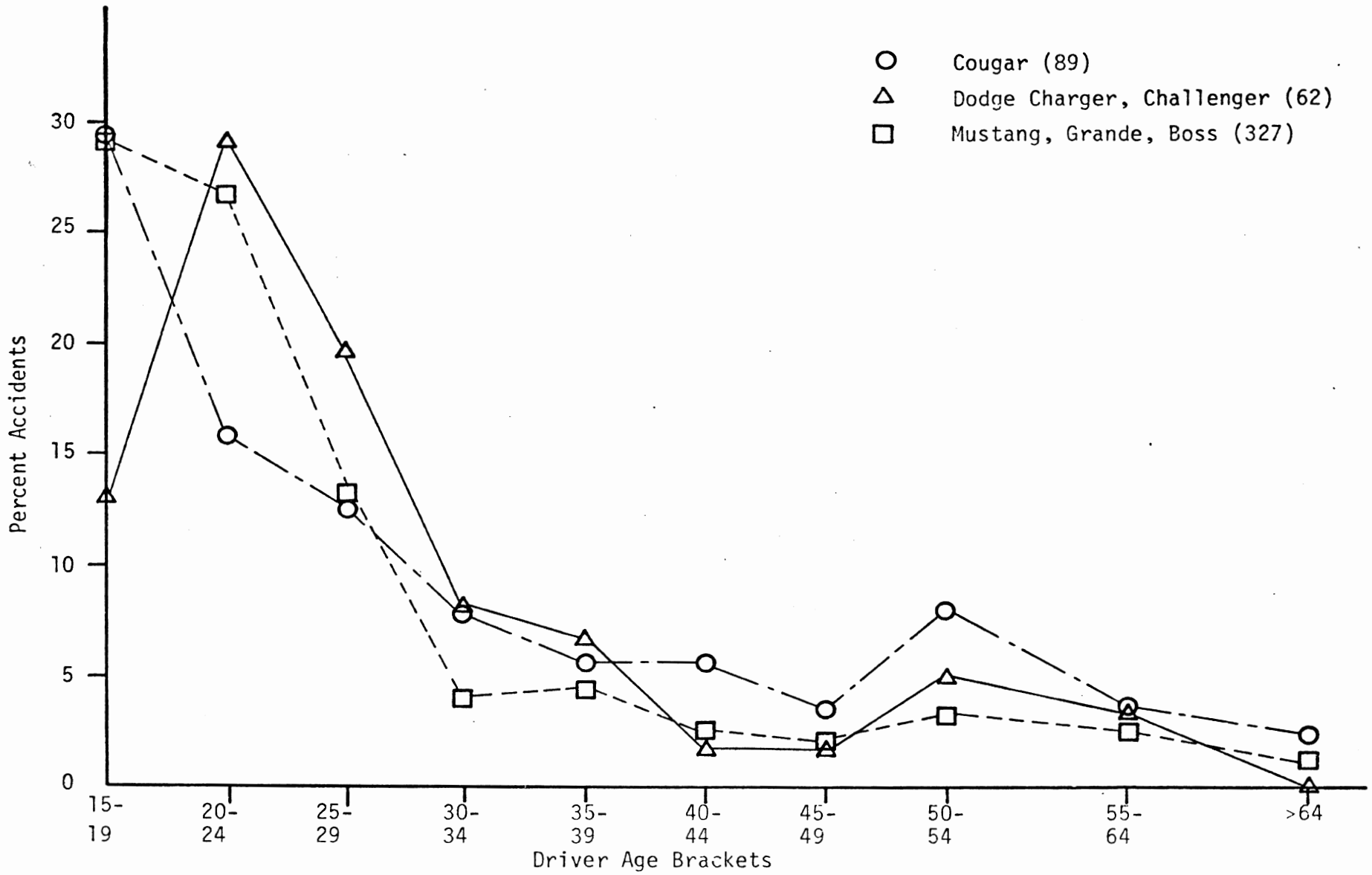


Figure B.1. Percent accidents by age bracket (specialty/pony).

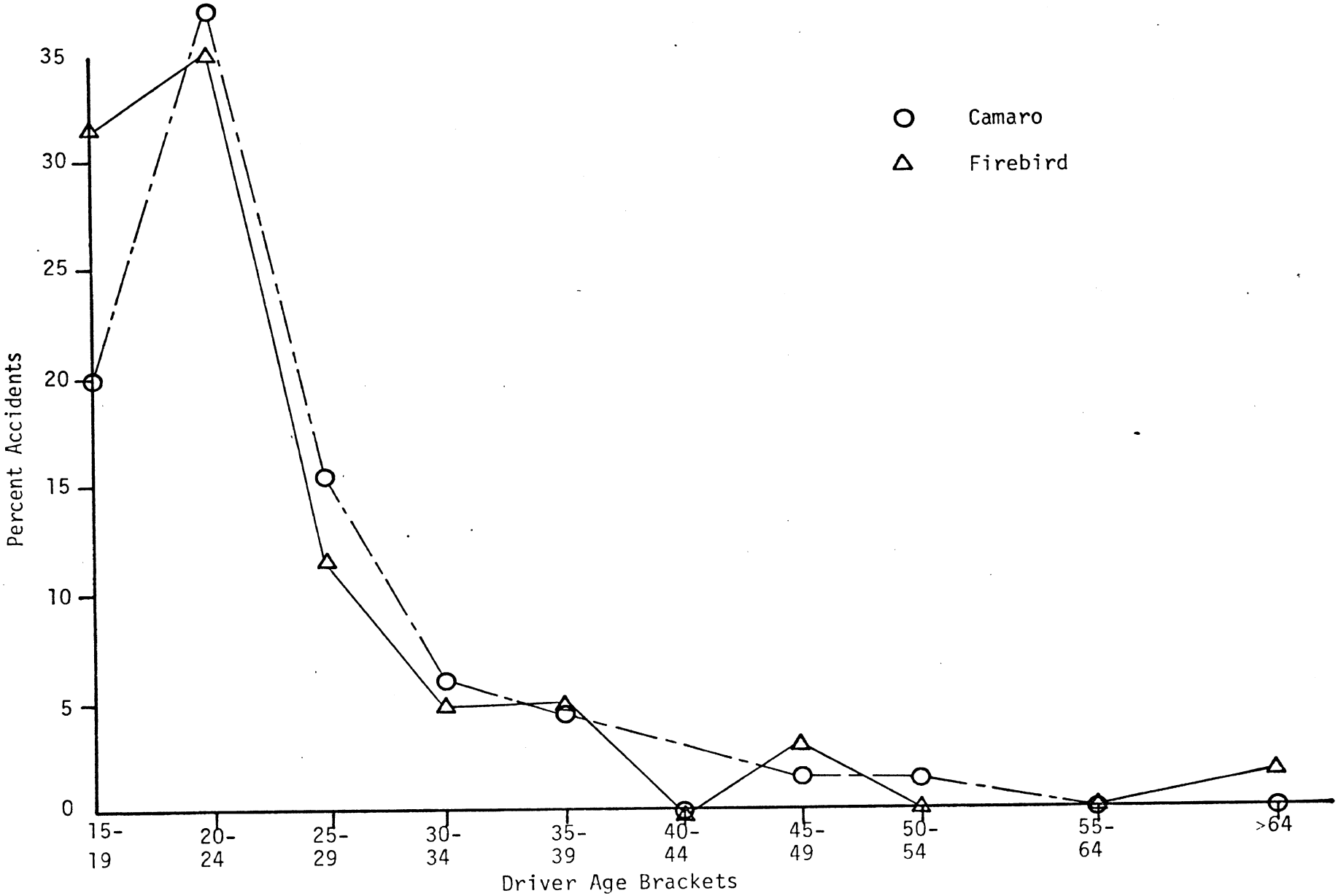


Figure B.2. Percent accidents by age brackets (specialty/pony)

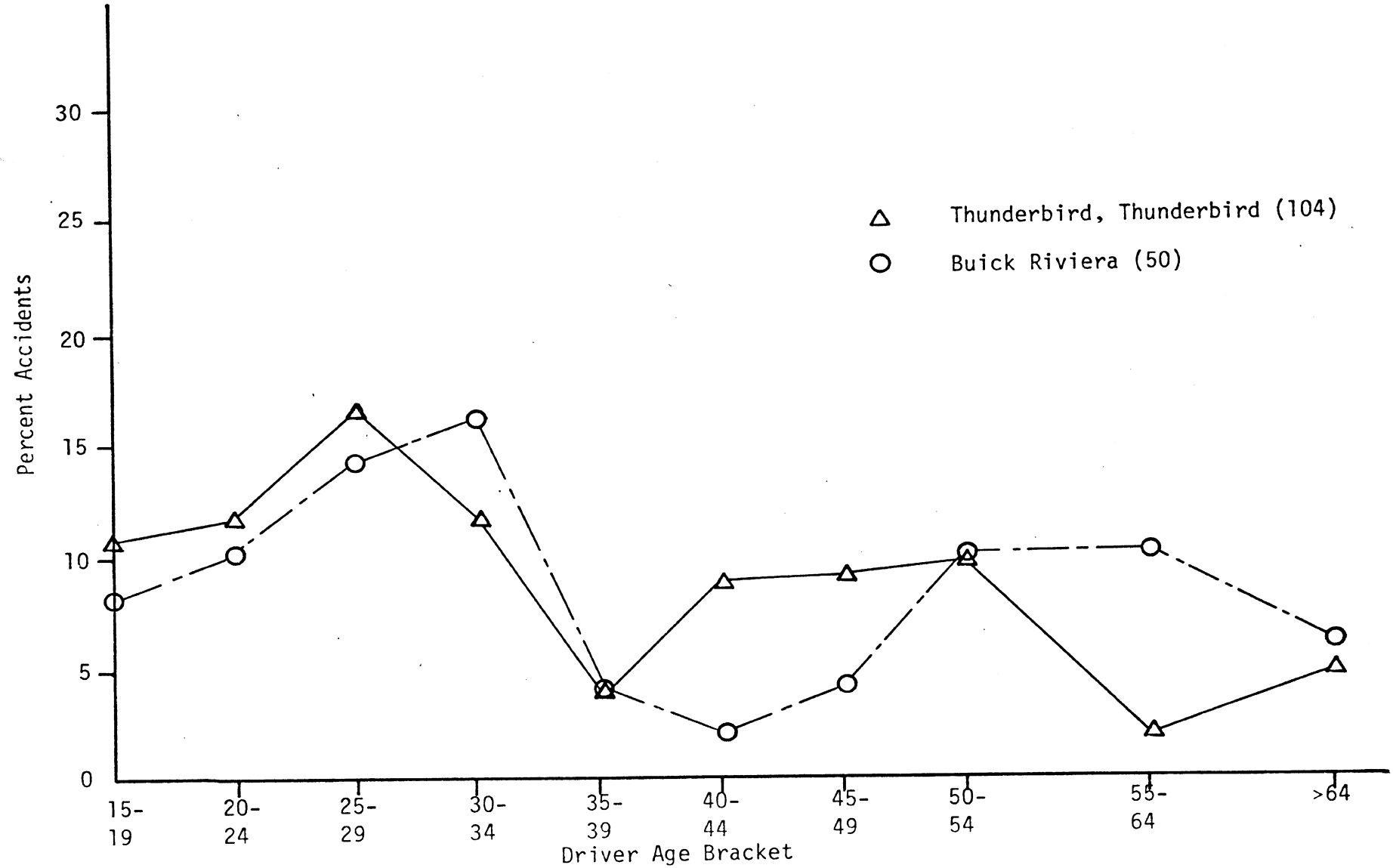


Figure B.3. Percent accidents by age bracket (personal luxury).

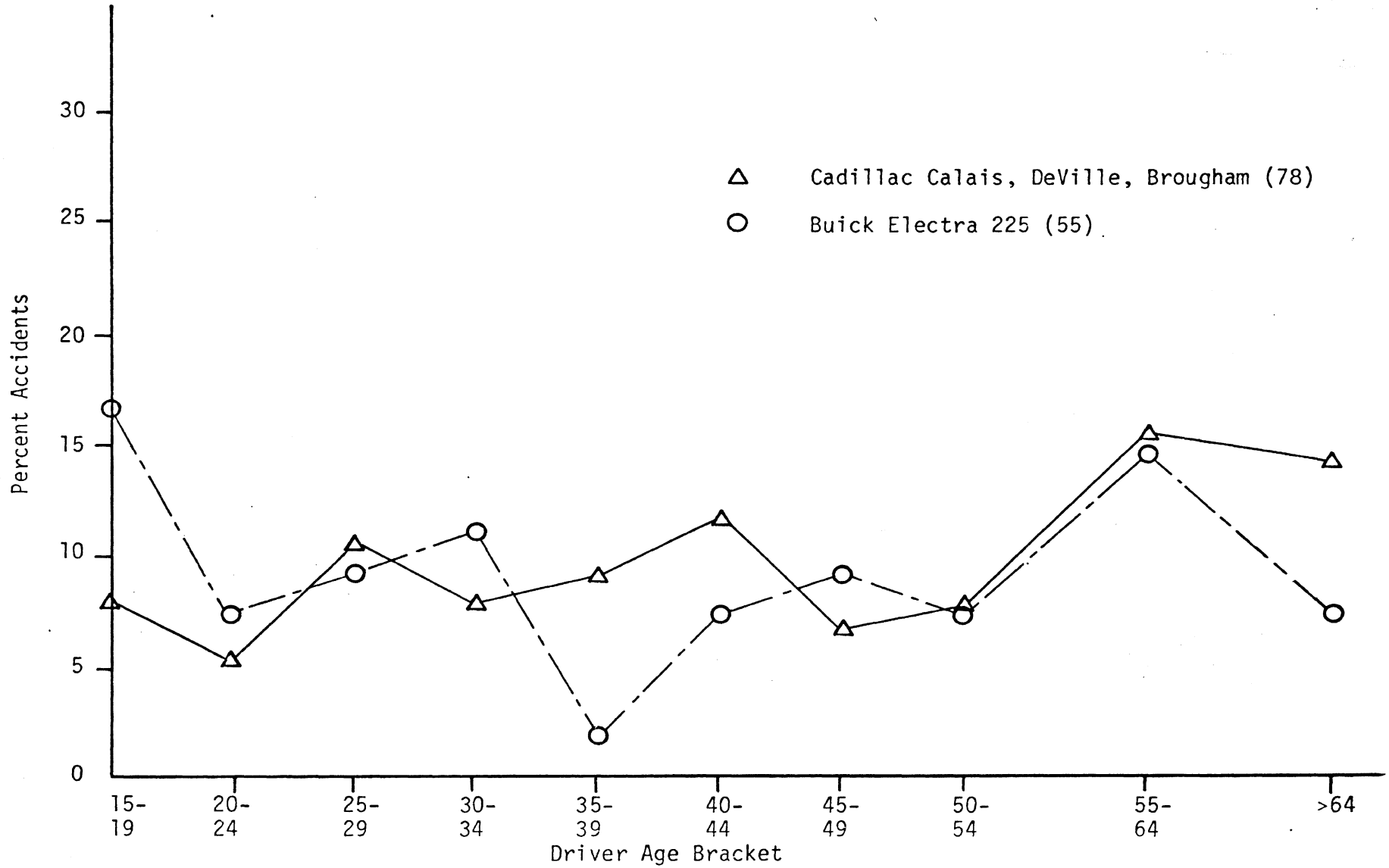


Figure B.4. Percent accidents by age bracket (luxury sedan).

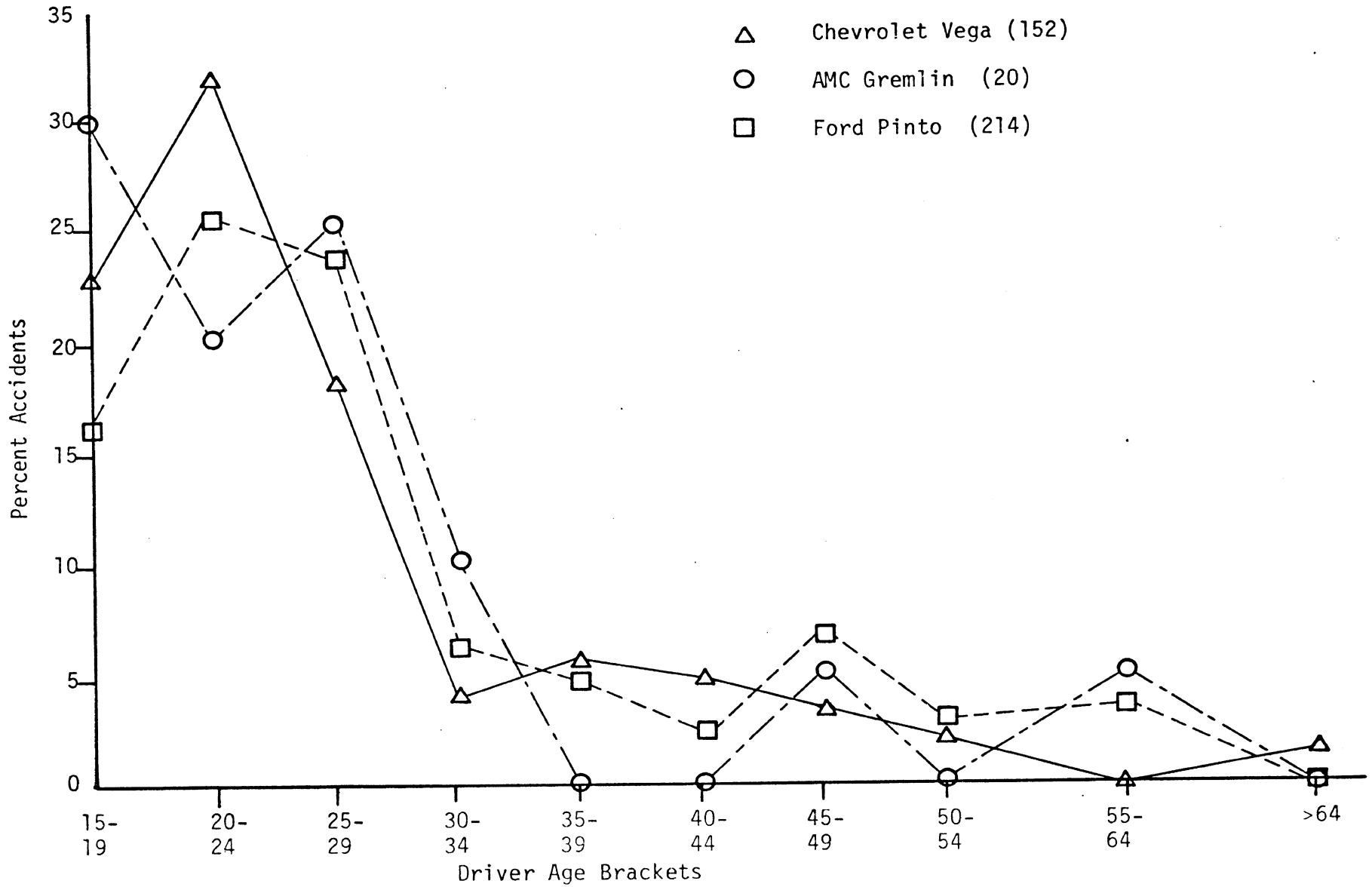


Figure B.5. Percent accidents by age bracket (sub-compact).

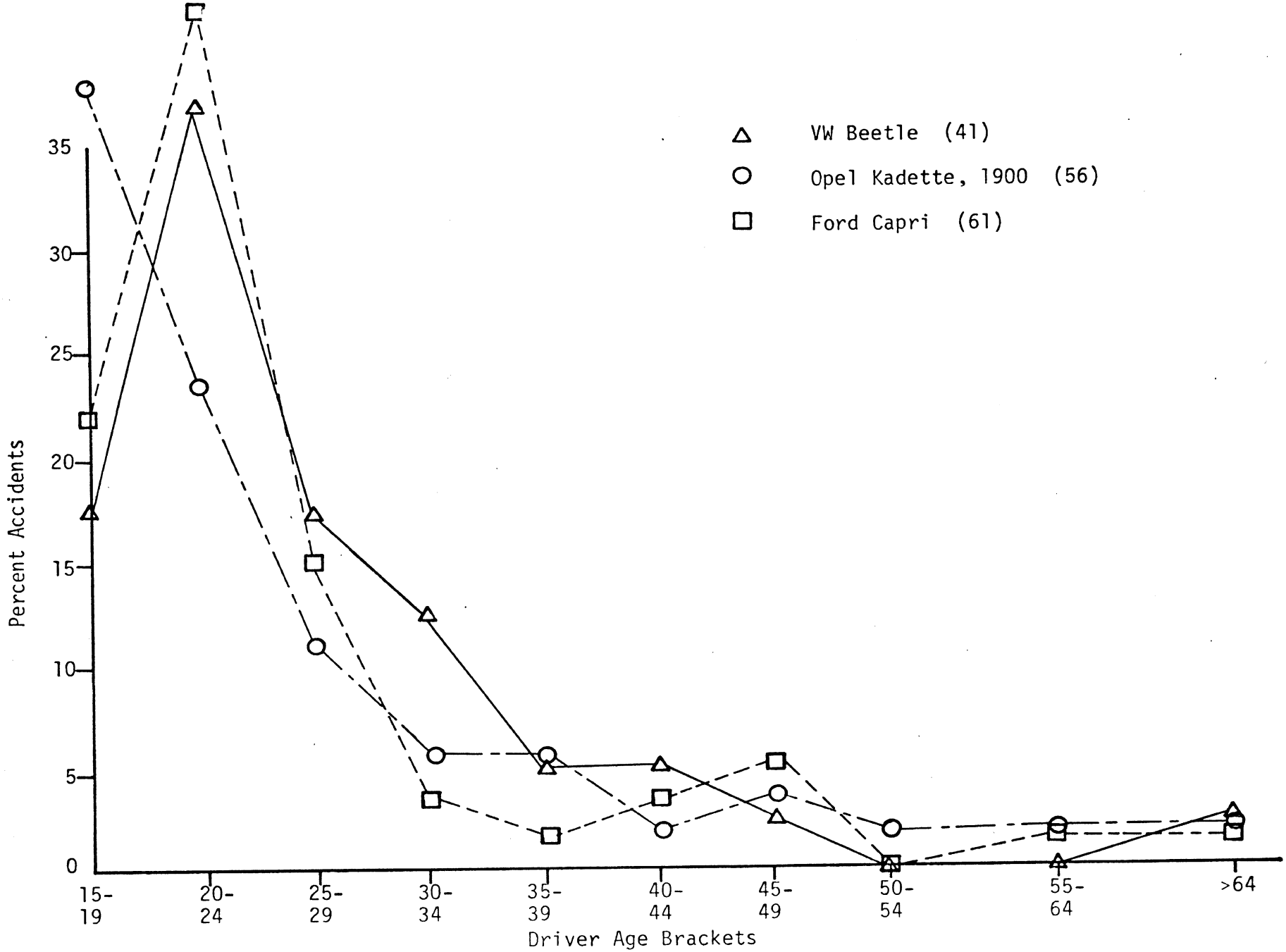


Figure B.6. Percent accidents by age bracket (sub-compact/mini).

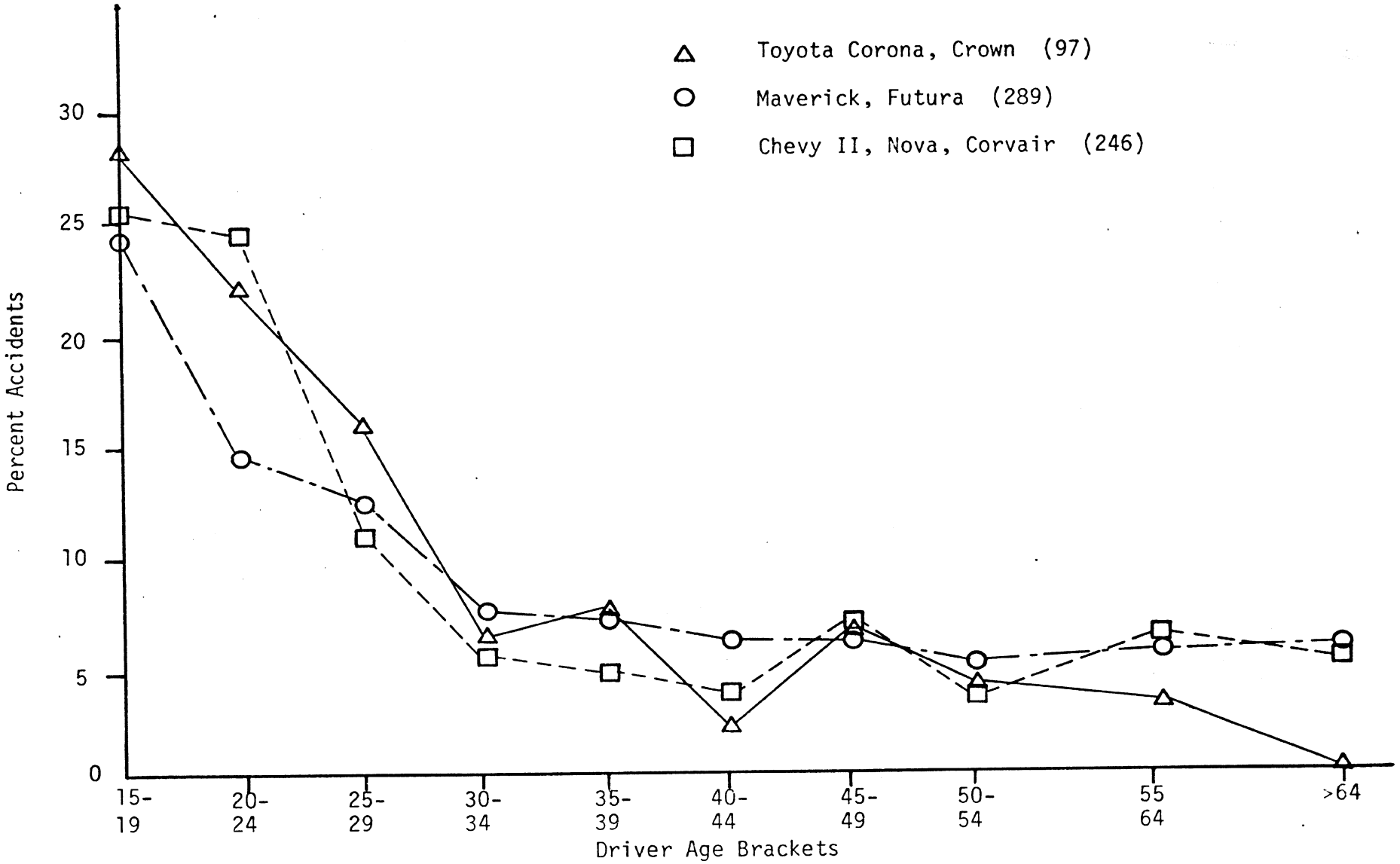


Figure B.7. Percent accidents by age bracket (compact).

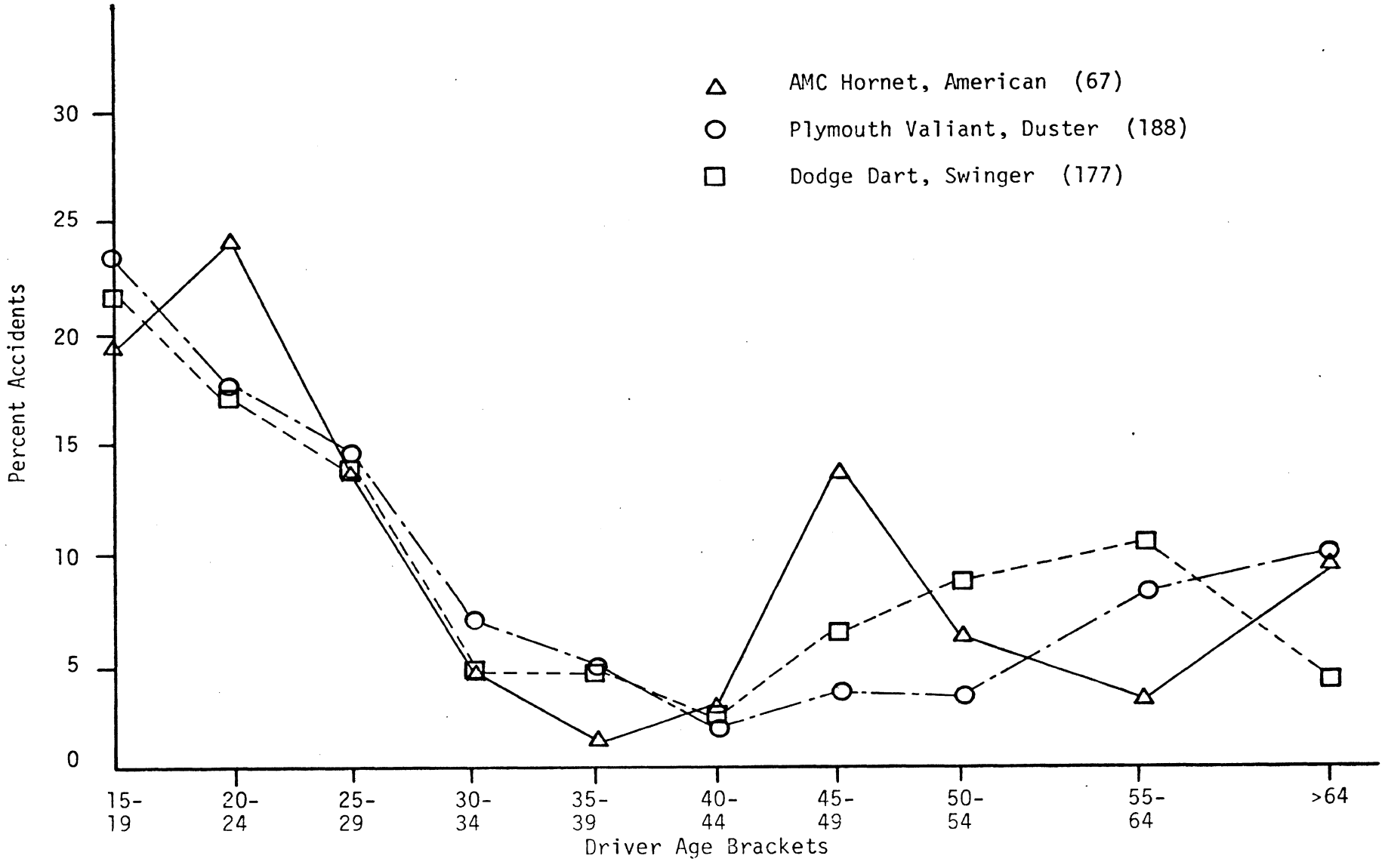


Figure B.8. Percent accidents by age bracket (compact).

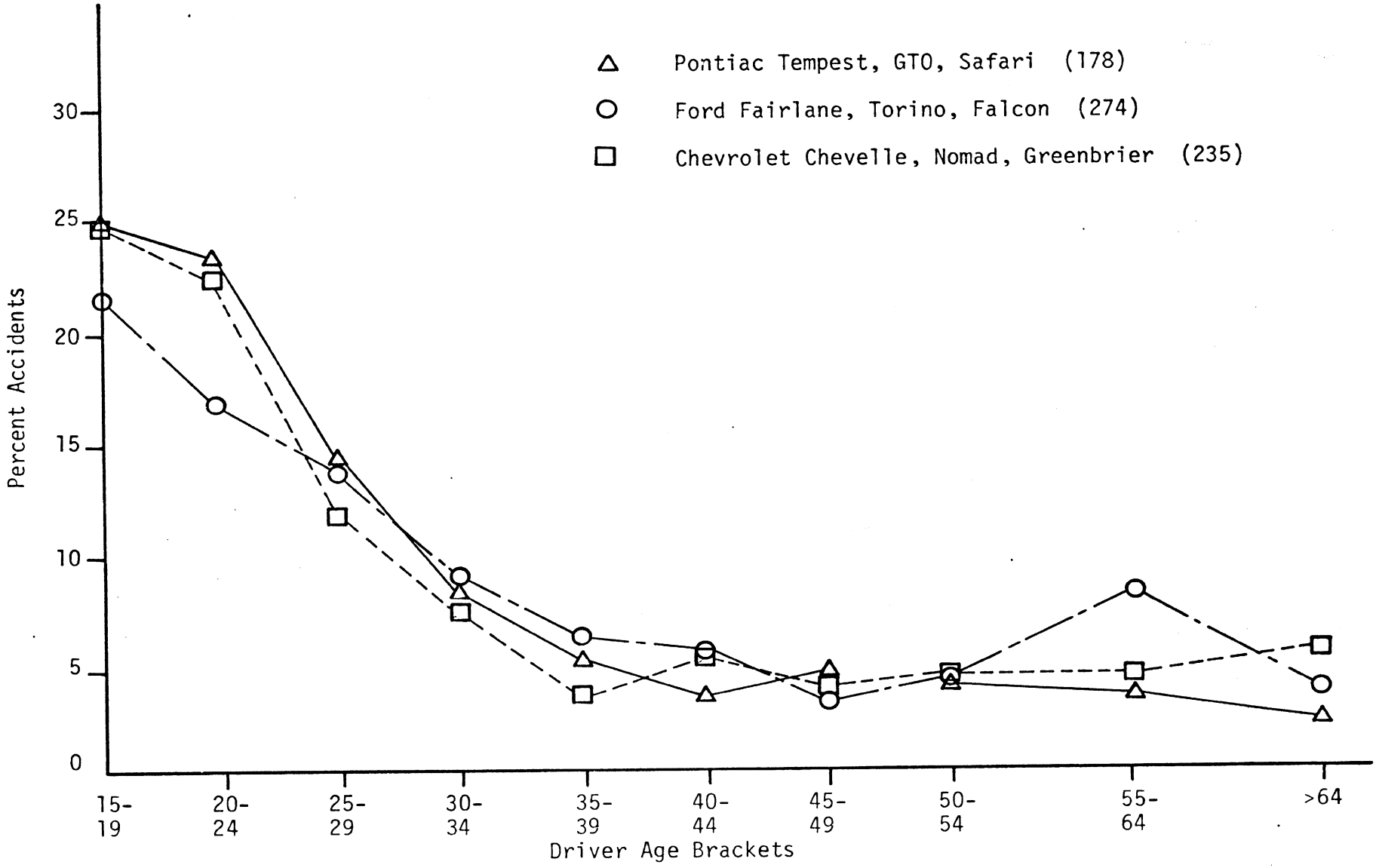


Figure B.9. Percent accidents by age bracket (intermediate).

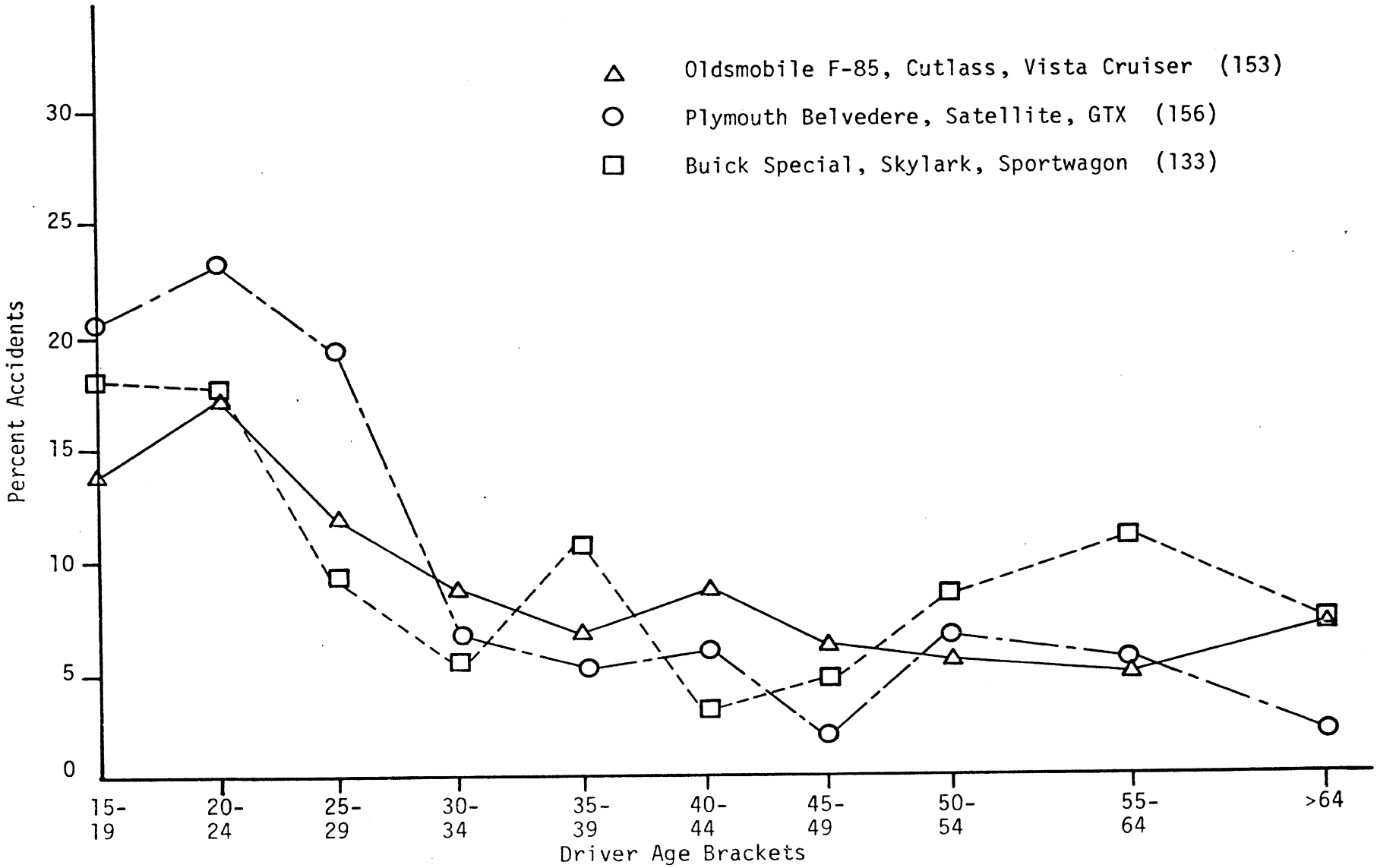


Figure B.10. Percent accidents by age bracket (intermediate).

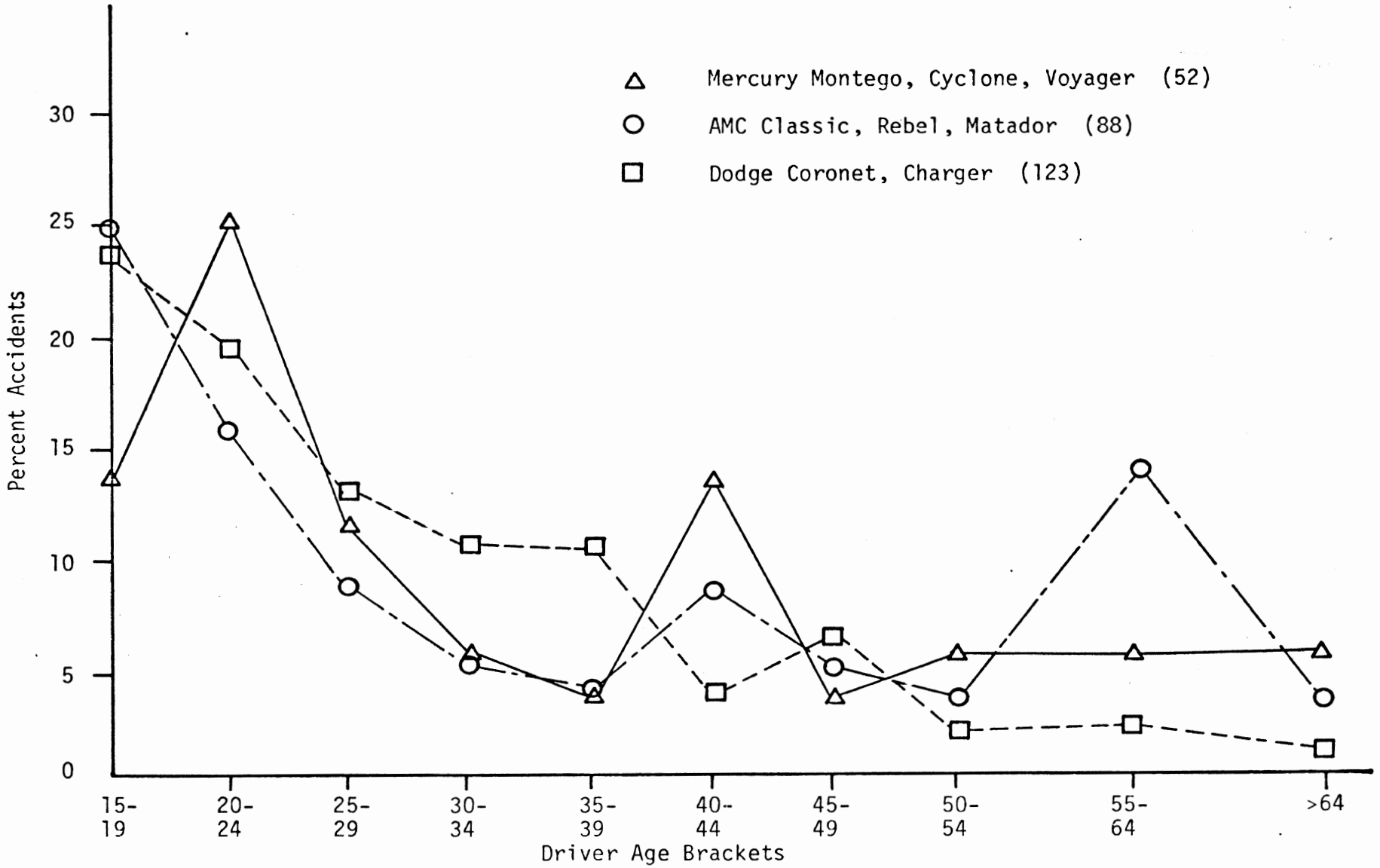


Figure B.11. Percent accidents by age bracket (intermediate).

With the standard/full-size vehicles (Figures B.12 to B.14), the trend of higher accidents at younger ages is not as pronounced. Beyond age 24, accident experience is relatively uniform across the higher age brackets. Again, the data are grouped according to numbers of accidents for specific models. The data are noticeably more erratic on Figure B.14 than on Figure B.12.

The mean age for each make/model is given on Table B.42. The make/models having the youngest and oldest mean age values are given in Table B.43. Body types ranked in terms of increasing mean driver age are given in Table B.44. It is quite evident that vehicles having accidents with the youngest drivers are the European sports cars, specialty/pony, sub-compact, and sub-compact/mini classes. Older drivers have the most accidents in the luxury sedan and personal luxury classes.

The most involved and least involved body types for each of the age groups is listed as follows.

Age Group	Most Involved	Least Involved
15-19	Specialty/Pony	Personal Luxury
20-24	European Sports Car	Luxury Sedan
25-29	Sub-Compact	Standard/Full Size
30-34	Personal Luxury	Sub-Compact
35-39	Standard/Full Size	Super Sport
40-44	Luxury Sedan	Specialty/Pony
45-49	Luxury Sedan	European Sports Car
50-54	Personal Luxury	Sub-Compact/Mini
55-64	Luxury Sedan	European Sports Car
>64	Luxury Sedan	European Sports Car

There is clearly a trend through the age groups from accidents with the sporty vehicles at younger ages, to the smaller domestic vehicles during the young family years, to the luxury models in middle and old age.

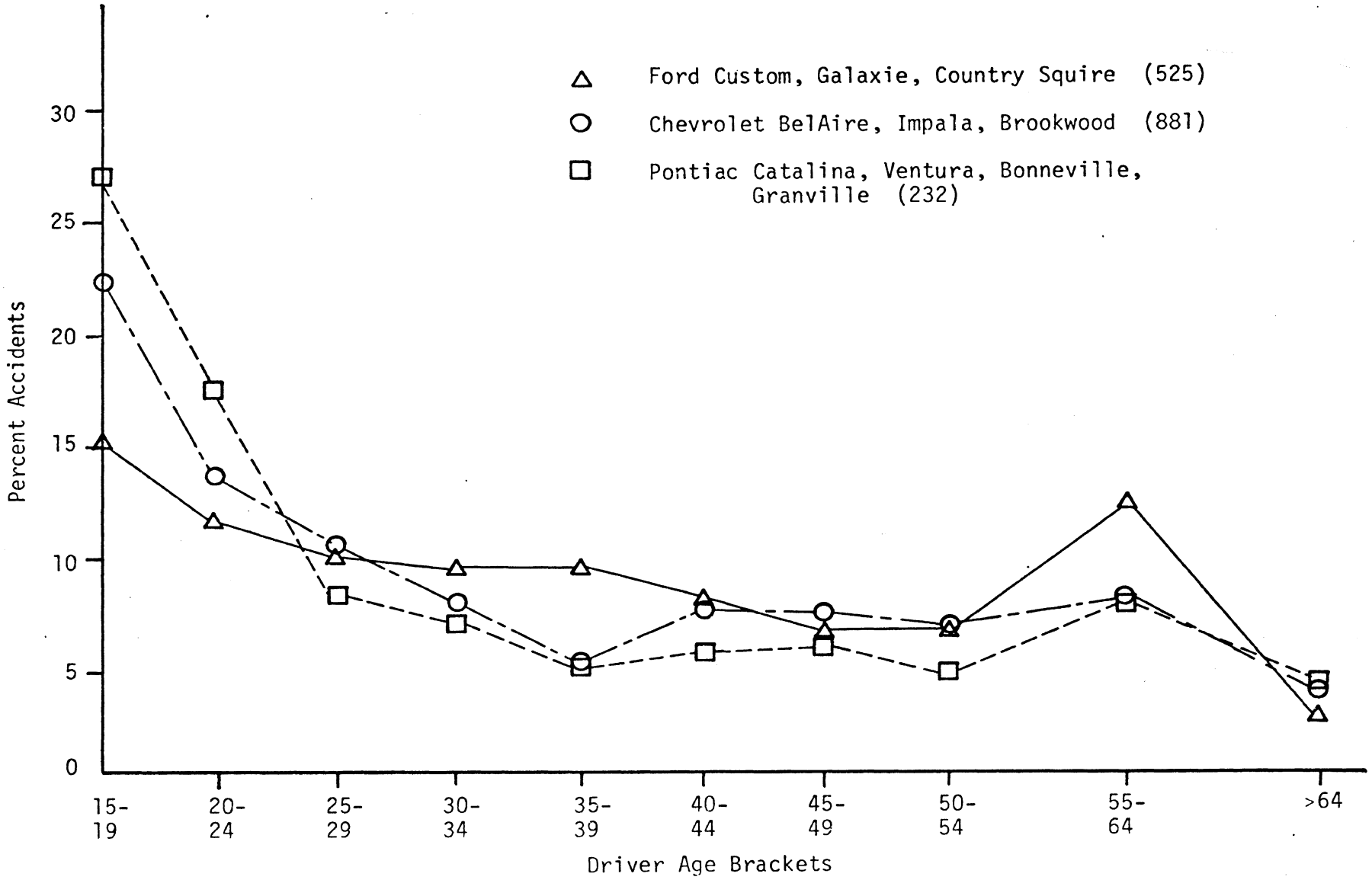


Figure B.12. Percent accidents by age bracket (standard/full size).

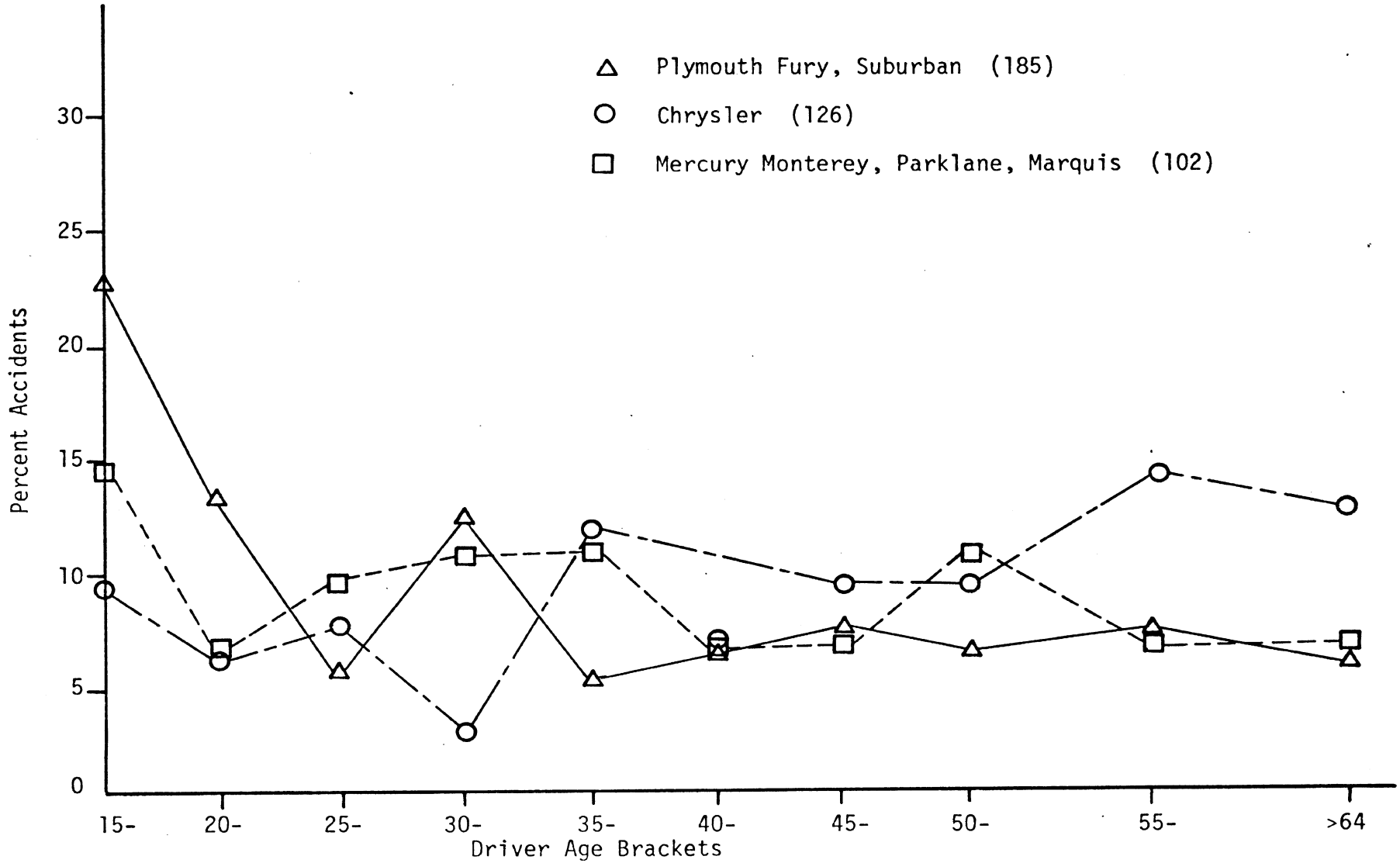


Figure B.13. Percent accidents by age bracket (standard/full size).

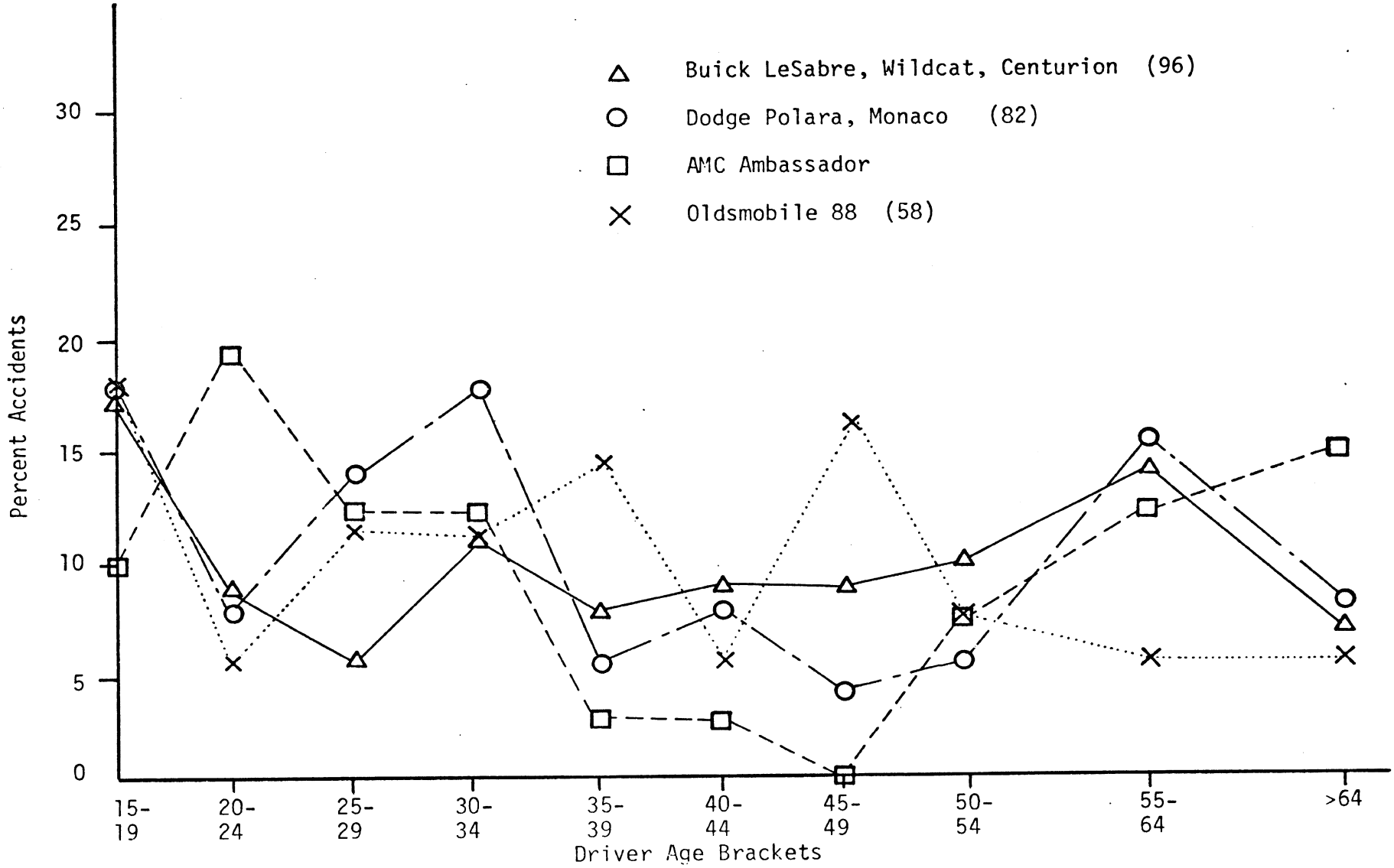


Figure B.14. Percent accidents by age bracket (standard/full size).

APPENDIX C

INDIRECT STANDARDIZATION - AN EXAMPLE

As a test of the analytical methodology developed in Section 7.1, analyses were carried out on existing data from corresponding accident and exposure files currently maintained at the Highway Safety Research Institute. Accident rates were established for three geographic areas: (1) the State of Texas, (2) King County (Seattle) Washington, and (3) Washtenaw County (Ann Arbor) Michigan. For each, an appropriate accident and exposure file exists, although none is adequate with respect to the requirements established in Section 7.3. The methods of indirect standardization were applied only to the King County accident rates.

The Texas accident file was derived from a larger file of all vehicles involved in police-reported accidents in the State of Texas in 1970. The smaller file used here consisted of a randomly chosen sample of 5% of the vehicles involved in accidents in the larger file. Of the accident variables recommended for use in Section 7.3.2, driver age and sex, weather and light conditions, and vehicle make, model and model year, among others, are included in this data file. After filtering out those cases which appeared to be most probably related to vehicle handling factors (see Section 5.1.2), approximately 19,000 cases remained. Missing data was handled by assigning the missing elements to cells in proportion to cell size.

The Texas exposure data was derived from a Driver Exposure File, also maintained at the Highway Safety Research Institute. This file contains 8,000 records of interviews conducted at driver license renewal offices throughout the country during 1970. Four of these offices were in Texas: El Paso, Corpus Christi, McCullock-Coleman County, and Houston, and over 400 interviews were conducted at these offices. Variables of interest that were

recorded during the interviews included mileage by driver age and sex, light and weather conditions, and vehicle make, model, and model year. Mileage figures are for 30 days. One drawback is that the make, model, and model year information was self-reported and the model, especially, is subject to error. This latter variable was therefore not used in the subsequent analysis.

One problem connected with using this particular exposure file was that the sampling rates were not known. Since this example is a test of the technique, accuracy is not necessarily a prime consideration. The estimated cell mileages for the entire State of Texas were therefore determined by multiplying by:

$$\frac{\text{TOTAL ESTIMATED TRAVEL MILES FOR TEXAS IN 1970}}{\text{TOTAL SAMPLE INTERVIEW MILES}}$$

The numerator estimate was obtained from Reference 128.

Another difficulty with this exposure file is that combinations of factors are not reported. To overcome this difficulty, independence of factors was assumed and the marginals of each separate confounding variable were multipled to obtain combined factors. For example, if an individual did 10% of his driving in the rain, and 20% at night, then (.10)(.20) = 2% (.2) was assumed to be driven on rainy nights.

Given the simplifications and approximations stated above, the estimated number of accidents in Texas in 1970 by age, sex, light and weather conditions is presented in Table C.1. The associated mileage estimates are given in Table C.2, and the ratios (accident rates) are given in Table C.3.

It is apparent that some of the accident rates are very much larger than the others. There may be a number of reasons why these statistics could be in error. Given all the simplifying assumptions and the possible biases in the data, it would be best to compare these figures with others from different populations before any conclusions are drawn.

TABLE C.1

ESTIMATED NUMBER OF VEHICLE HANDLING RELATED ACCIDENTS IN TEXAS IN 1970
BY
AGE, SEX, LIGHT, AND WEATHER*

ALL FACTORS ACCIDENTS

AGE/SEX	≤25	26-40	>40	TOTAL
M	102,331	59,285	74,503	236,119
F	50,346	39,682	49,513	139,541
TOTAL	152,677	98,967	124,016	375,660

DAY ACCIDENTS, ONLY

AGE/SEX	≤25	26-40	>40	TOTAL
M	69,119	41,312	59,827	170,258
F	40,675	33,055	43,192	116,922
TOTAL	109,794	74,367	103,019	287,180

NIGHT ACCIDENTS, ONLY

AGE/SEX	≤25	26-40	>40	TOTAL
M	33,687	18,179	14,489	66,355
F	9,570	6,494	6,061	22,125
TOTAL	43,257	24,673	20,550	88,480

DRY WEATHER ACCIDENTS, ONLY

AGE/SEX	≤25	26-40	>40	TOTAL
M	81,892	48,146	61,131	191,169
F	41,667	31,754	41,830	115,251
TOTAL	123,559	79,900	102,961	306,420

WET WEATHER ACCIDENTS, ONLY

AGE/SEX	≤25	26-40	>40	TOTAL
M	20,398	11,133	13,380	44,911
F	8,695	7,915	7,719	24,329
TOTAL	29,093	19,048	21,099	69,240

* Note: All accident and mileage numbers in this and all other tables have been adjusted to account for missing data. Because of this, the sum of the accident figures in each set of comparable cells from the levels of a variable may not equal the total accidents for that cell.

TABLE C.2

ESTIMATED NUMBER OF MILES DRIVEN IN TEXAS IN 1970
BY
AGE, SEX, LIGHT, AND WEATHER*

ALL FACTORS

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	12,255.5	23,295.4	25,698.6	61,249.5
F	948.1	2,736.7	3,096.7	6,781.5
TOTAL	13,203.6	26,032.1	28,795.3	68,031

DAY ONLY MILEAGE

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	11,805.0	16,817.7	16,721.2	45,343.9
F	929.7	2,207.6	3,032.6	6,169.9
TOTAL	12,734.7	19,025.3	19,753.8	51,513.8

NIGHT ONLY MILEAGE

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	4,130.2	6,995.4	3,906.0	15,031.6
F	375.6	492.7	617.3	1,485.6
TOTAL	4,505.8	7,488.1	4,523.3	16,517.2

DRY WEATHER ONLY MILEAGE

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	12,504.4	14,838.1	14,200.0	41,542.5
F	784.3	1,609.1	2,374.3	4,767.7
TOTAL	13,288.7	16,447.2	16,574.3	46,310.2

WET WEATHER ONLY MILEAGE

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	3,430.8	8,974.6	6,427.3	18,832.7
F	521.0	1,091.4	1,275.7	2,888.1
TOTAL	3.951.8	10,066.0	7,703.0	21,720.8

*All numbers are in units of 10^6 miles.

TABLE C.3

ESTIMATED VEHICLE HANDLING RELATED ACCIDENT RATES IN TEXAS IN 1970

BY

AGE, SEX, LIGHT, AND WEATHER*

ALL FACTORS ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	8.35	2.55	2.90	3.86
F	53.10	14.50	15.99	20.58
TOTAL	11.56	3.80	4.31	5.52

DAY ONLY ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	5.86	2.46	3.58	3.76
F	43.75	14.97	14.24	18.95
TOTAL	8.62	3.91	5.22	5.58

NIGHT ONLY ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	8.16	2.60	3.71	4.91
F	25.48	13.18	9.82	14.89
TOTAL	9.60	3.30	4.54	5.36

DRY WEATHER ONLY ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	6.55	3.25	4.31	4.60
F	53.13	19.73	17.62	24.17
TOTAL	9.30	4.86	6.21	6.62

WET WEATHER ONLY ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	5.95	1.24	2.08	2.39
F	16.69	7.25	6.05	8.42
TOTAL	7.36	1.89	2.74	3.19

*All numbers are in units of accidents/10^6 miles.

Accident mileage exposure, and accident rate statistics for King County (Seattle), Washington are given in Tables C.4, C.5, and C.6. The accident file consisted of all accidents in King County in the year 1970 and the exposure information came from the same driver exposure files as the Texas data, but was filtered for King County drivers only. In addition to the variables used in the Texas analysis, the accident file also contains the road class and vehicle make variables. There are 220 interviews in the exposure file and 19,000 accidents in the accident file. The accident rates for King County are more consistent than for Texas, yet there are still wide differences, particularly with respect to driver sex.

The final set of statistics are from Washtenaw County (Ann Arbor), Michigan. The exposure data is from an exposure survey conducted in 1973. There were 1,100 interviews conducted, with most of the same variables recorded as the national exposure survey. Unfortunately, vehicle make was not recorded and it is not included in the analysis of this population. The corresponding accident data is from a file of all Michigan accidents in 1973 filtered on those which occurred in Washtenaw County. (The county of residence of the driver was not listed in this file. Therefore, the analysis was centered on accidents occurring in Washtenaw County independent of the driver's residence.) This accident data file was also filtered to remove all non-handling-related accidents with the result that 2,600 cases remained for analysis. Tables C.7, C.8, and C.9 present the accident, mileage, and accident rate statistics for Washtenaw County. The accident rates for Washtenaw County are of the same order of magnitude as those for the King County data. This finding tends to reinforce the impression that the accident rate estimates for Texas are in error.

TABLE C.4

ESTIMATED NUMBER OF VEHICLE HANDLING RELATED ACCIDENTS IN KING COUNTY, WASHINGTON IN 1970

BY

AGE, SEX, LIGHT, WEATHER, ROAD CLASS, AND VEHICLE MAKE*

ALL FACTORS ACCIDENTS

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	5,610	3,792	4,071	13,473
F	2,343	1,665	1,957	5,965
TOTAL	7,953	5,457	6,028	19,438

DAY ACCIDENTS, ONLY

AGE/SEX	≤ 25	26-40	>40	TOTAL
M	3,248	2,340	2,861	8,449
F	1,626	1,228	1,482	4,336
TOTAL	4,874	3,568	4,343	12,785

NIGHT ACCIDENTS, ONLY

AGE/SEX	≤ 25	26-40	>40	TOTAL
M	2,366	1,453	1,206	5,025
F	712	431	467	1,510
TOTAL	3,078	1,884	1,673	6,635

DRY WEATHER ACCIDENTS, ONLY

AGE/SEX	≤ 25	26-40	>40	TOTAL
M	3,484	2,394	2,683	8,561
F	1,482	1,080	1,278	3,840
TOTAL	4,966	3,474	3,961	12,401

WET WEATHER ACCIDENTS, ONLY

AGE/SEX	≤ 25	26-40	>40	TOTAL
M	2,125	1,397	1,389	4,911
F	861	585	680	2,126
TOTAL	2,986	1,982	2,069	7,037

*All numbers have been adjusted to correct for missing data.

TABLE C.4 (Cont.)

ACCIDENTS ON STREETS, ONLY

AGE/SEX	25	26-40	40	TOTAL
M	4,389	2,893	3,181	10,463
F	1,794	1,290	1,575	4,659
TOTAL	6,183	4,183	4,756	15,122

ACCIDENTS ON FREEWAYS, ONLY

AGE/SEX	25	26-40	40	TOTAL
M	512	386	439	1,337
F	240	177	161	578
TOTAL	752	563	600	1,915

ACCIDENTS ON ROADS, ONLY

AGE/SEX	25	26-40	40	TOTAL
M	691	496	440	1,627
F	293	193	207	693
TOTAL	984	689	647	2,320

ACCIDENTS BY VEHICLE MAKE

AMERICAN MOTORS	575
BUICK	1,115
CADILLAC	401
CHEVROLET	5,228
CHRYSLER	367
DODGE	1,212
FORD	4,792
LINCOLN	153
MERCURY	672
OLDSMOBILE	748
PLYMOUTH	1,677
PONTIAC	1,547
VOLKSWAGON	140
OTHER	808
TOTAL	19,438

TABLE C.5

ESTIMATED NUMBER OF MILES DRIVEN IN KING COUNTY, WASHINGTON IN 1970

BY

AGE, SEX, LIGHT, WEATHER, ROAD CLASS, AND VEHICLE MAKE*

ALL FACTORS

AGE/SEX	≤25	26-40	>40	TOTAL
M	1,893.4	2,059.3	1,928.6	5,881.3
F	212.6	280.5	668.9	1,162.0
TOTAL	2,106.0	2,339.8	2,597.5	7,043.3

DAY ONLY MILEAGE

AGE/SEX	≤25	26-40	>40	TOTAL
M	1,165.7	1,594.8	1,619.8	4,380.3
F	143.1	218.3	550.6	912.0
TOTAL	1,308.8	1,813.1	2,170.4	5,292.3

NIGHT ONLY MILEAGE

AGE/SEX	≤25	26-40	>40	TOTAL
M	725.7	468.1	312.0	1,505.8
F	67.7	58.8	118.7	245.2
TOTAL	793.4	526.9	430.7	1,751.0

DRY WEATHER ONLY MILEAGE

AGE/SEX	≤25	26-40	>40	TOTAL
M	1,083.8	1,189.3	1,408.4	3,681.5
F	123.9	201.2	461.8	786.9
TOTAL	1,207.7	1,390.5	1,870.2	4,468.4

WET WEATHER ONLY MILEAGE

AGE/SEX	≤25	26-40	>40	TOTAL
M	807.7	873.6	523.4	2,204.7
F	86.9	75.8	207.5	370.2
TOTAL	894.6	949.4	730.9	2,574.9

*All numbers are in units of 10^6 miles.

TABLE C.5 (Cont.)

MILEAGE ON STREETS, ONLY

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	963.0	761.3	908.6	2,632.9
F	86.6	166.1	434.2	686.9
TOTAL	1,049.6	927.4	1,342.8	3,319.8

MILEAGE ON FREEWAYS, ONLY

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	822.2	1,044.7	865.5	2,732.4
F	96.3	107.0	220.3	422.6
TOTAL	917.5	1,151.7	1,085.8	3,155.0

MILEAGE ON ROADS, ONLY

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	106.2	256.9	157.6	520.7
F	28.9	4.0	14.8	47.7
TOTAL	135.9	260.9	172.4	568.4

MILEAGE BY VEHICLE MAKE

AMERICAN MOTORS	103.0
BUICK	761.5
CADILLAC	188.5
CHEVROLET	1,420.6
CHRYSLER	58.0
DODGE	343.2
FORD	2,015.7
LINCOLN	4.6
MERCURY	141.2
OLDSMOBILE	298.2
PLYMOUTH	366.1
PONTIAC	201.5
VOLKSWAGON	658.6
OTHER	482.8
TOTAL	7,043.5

TABLE C.6

ESTIMATED VEHICLE HANDLING RELATED ACCIDENT RATES IN KING COUNTY IN 1970
BY
AGE, SEX, LIGHT, WEATHER, ROAD CLASS, AND VEHICLE MAKE*

ALL FACTORS ACCIDENT RATES

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	2.96	1.84	2.11	2.29
F	11.03	5.94	2.93	5.13
TOTAL	3.78	2.33	2.32	2.76

DAY ONLY ACCIDENT RATES

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	2.79	1.47	1.77	1.93
F	11.36	5.63	2.69	4.75
TOTAL	3.73	1.97	2.00	2.42

NIGHT ONLY ACCIDENT RATES

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	3.26	3.10	3.87	3.38
F	10.52	7.33	3.93	6.57
TOTAL	3.88	3.58	3.88	3.79

DRY WEATHER ONLY ACCIDENT RATES

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	3.21	2.01	1.91	2.33
F	11.96	5.37	2.77	4.88
TOTAL	4.11	2.50	2.12	2.78

WET WEATHER ONLY ACCIDENT RATES

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	2.63	1.60	2.66	2.23
F	9.91	7.71	3.27	5.74
TOTAL	3.34	2.09	2.83	2.73

*All numbers are in units of accidents/10^6 miles.

TABLE C.6 (Cont.)

ACCIDENT RATES ON STREETS, ONLY

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	4.56	3.80	3.50	3.97
F	20.73	7.77	3.63	6.78
TOTAL	5.89	4.51	3.54	4.56

ACCIDENT RATES ON FREEWAYS, ONLY

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	0.62	0.37	0.51	0.49
F	2.52	1.65	0.73	1.37
TOTAL	0.82	0.49	0.55	0.61

ACCIDENTS RATES ON ROADS, ONLY

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	6.50	1.93	2.79	3.12
F	10.13	48.34	14.00	14.53
TOTAL	7.28	2.64	3.76	4.08

RAW ACCIDENT RATES BY VEHICLE MAKE

AMERICAN MOTORS	5.59
BUICK	1.46
CADILLAC	2.13
CHEVROLET	3.68
CHRYSLER	6.32
DODGE	3.53
FORD	2.38
IMPERIAL	----
LINCOLN	0.36
MERCURY	4.76
OLDSMOBILE	2.51
PLYMOUTH	4.58
PONTIAC	7.68
VOLKSWAGON	0.21
OTHER	1.67
TOTAL	2.76

TABLE C.7

ESTIMATED NUMBER OF VEHICLE HANDLING RELATED ACCIDENTS IN WASHTENAW COUNTY, MICHIGAN IN 1973

BY

AGE, SEX, LIGHT, AND WEATHER

ALL FACTORS ACCIDENTS

AGE/SEX	≤ 25	26-40	> 40	TOTAL
M	1,202	629	493	2,324
F	683	377	287	1,347
TOTAL	1,885	1,006	780	3,671

DAY ACCIDENTS, ONLY

AGE/SEX	≤25	26-40	> 40	TOTAL
M	754	385	357	1,496
F	484	293	219	996
TOTAL	1,238	678	576	2,492

NIGHT ACCIDENTS, ONLY

AGE/SEX	≤25	26-40	> 40	TOTAL
M	446	243	132	821
F	197	84	68	349
TOTAL	643	327	200	1,170

DRY WEATHER ACCIDENTS, ONLY

AGE/SEX	≤25	26-40	> 40	TOTAL
M	802	431	347	1,580
F	466	263	200	929
TOTAL	1,268	694	547	2,509

WET WEATHER ACCIDENTS, ONLY

AGE/SEX	≤25	26-40	> 40	TOTAL
M	393	193	142	728
F	215	113	85	413
TOTAL	608	306	227	1,141

TABLE C.8

ESTIMATED NUMBER OF MILES DRIVEN IN WASHTENAW COUNTY, MICHIGAN IN 1973
BY
AGE, SEX, LIGHT, AND WEATHER*

ALL FACTORS

AGE/SEX	25	26-40	40	TOTAL
M	346.5	505.5	353.9	1,205.9
F	74.3	206.3	55.9	336.5
TOTAL	420.8	711.8	409.8	1,542.4

DAY ONLY MILEAGE

AGE/SEX	25	26-40	40	TOTAL
M	240.1	262.9	292.2	795.2
F	49.0	109.0	49.1	207.1
TOTAL	289.1	371.9	341.3	1,002.3

NIGHT ONLY MILEAGE

AGE/SEX	25	26-40	40	TOTAL
M	156.2	150.6	107.4	414.2
F	38.0	72.0	16.0	126.0
TOTAL	194.2	222.6	123.4	540.2

DRY WEATHER ONLY MILEAGE

AGE/SEX	25	26-40	40	TOTAL
M	216.0	157.6	160.7	534.3
F	38.7	67.5	31.5	137.7
TOTAL	254.7	225.1	192.2	672.0

WET WEATHER ONLY MILEAGE

AGE/SEX	25	26-40	40	TOTAL
M	181.2	257.1	236.3	674.6
F	48.2	113.9	33.8	195.9
TOTAL	229.4	371.0	270.1	870.5

*All numbers are in units of accidents/10^6 miles.

TABLE C.9

ESTIMATED VEHICLE HANDLING RELATED ACCIDENT RATES IN WASHTENAW COUNTY, MICHIGAN IN 1973

BY

AGE, SEX, LIGHT, AND WEATHER*

ALL FACTORS ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	3.47	1.24	1.39	1.93
F	9.19	1.83	5.13	4.00
TOTAL	4.48	1.41	1.90	2.38

DAY ONLY ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	3.14	1.46	1.22	1.88
F	9.88	2.69	4.46	4.81
TOTAL	4.28	1.82	1.69	2.49

NIGHT ONLY ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	2.86	1.61	1.23	1.98
F	5.18	1.17	4.26	2.77
TOTAL	3.31	1.47	1.62	2.17

DRY WEATHER ONLY ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	3.71	2.74	2.16	2.96
F	12.04	3.89	6.36	6.75
TOTAL	4.98	3.08	2.85	3.73

WET WEATHER ONLY ACCIDENT RATES

AGE/SEX	≤25	26-40	>40	TOTAL
M	2.17	0.75	0.60	1.08
F	4.46	0.99	2.52	2.11
TOTAL	2.65	0.83	0.84	1.31

*All numbers are in units of accidents/10^6 miles.

The technique of indirect standardization was applied to the Seattle data. Table C.6 showed the raw accident rates for the vehicle make, and the standard accident rates for each combination of factor levels. Table C.10 presents the standardized accident rates for the various vehicle classes, where weather and light conditions are accounted for. These rates were computed by using Equations (7.1) and (7.2) of Section 7, viz.:

$$R'_k = \frac{\sum_j r_{Sj} M_{kj}}{\sum_j M_{kj}} \qquad (7.1)$$

$$R_k^{ind} = R_S \frac{R_k}{R'_k} \qquad (7.2)$$

where the various r_{Sj} and M_{kj} data values were obtained from the appropriate data files. Mileage figures for the various combinations of light and weather conditions were estimated by assuming that light and weather are independent.

The standardized accident rates for each of the vehicle makes shown on Table C.10 represent the best estimate of accident proneness for a particular vehicle that can be obtained from available data. These rates should be considered as a demonstration of the use of the indirect standardization method, however, rather than as a true measure of accident susceptibility. There are too many limitations and inaccuracies in the existing exposure data to consider these rates as truly representative. Only when the procedures recommended in Section 7 are followed, and substantially more data are collected, can the results be considered meaningful. In the end, these more accurate standardized accident rates would be used as independent variables in a regression analysis.

TABLE C.10

RAW AND STANDARDIZED ACCIDENT RATES FOR KING COUNTY IN 1970 (R_S = 2.76)

VEHICLE MAKE	ACTUAL NUMBER OF ACCIDENTS	PREDICTED NUMBER OF ACCIDENTS	RAW ACCIDENT RATE, R_k^*	STANDARDIZED ACCIDENT RATE, R_k^{ind}
AMERICAN MOTORS	575	277	5.59	5.73
BUICK	1,115	2,199	1.46	1.40
CADILLAC	401	478	2.13	2.32
CHEVROLET	5,228	4,062	3.68	3.55
CHRYSLER	367	126	6.32	8.02
DODGE	1,212	1,067	3.53	3.14
FORD	4,792	5,363	2.38	2.47
IMPERIAL	3	-----	----	----
LINCOLN	153	-----	0.36	----
MERCURY	672	346	4.76	5.35
OLDSMOBILE	748	798	2.51	2.59
PLYMOUTH	1,677	919	4.58	5.04
PONTIAC	1,547	591	7.68	7.23
VOLKSWAGON	140	1,946	0.21	0.20
OTHER	808	1,491	1.67	1.50

*Accidents per 10^6 miles

TABLE C.10 (Cont.)

AGE	WEATHER	MALE		FEMALE	
		DAY	NIGHT	DAY	NIGHT
≤ 25	DRY	4.16	5.22	5.86	7.13
	WET	3.50	4.24	6.20	7.30
26-40	DRY	1.51	2.48	3.01	4.32
	WET	1.35	2.37	4.22	4.09
> 40	DRY	1.65	2.87	2.40	3.74
	WET	1.51	2.75	2.82	4.85

APPENDIX D

SUPPLEMENTAL ACCIDENT REPORT FORM FOR VEHICLE HANDLING

The accident report form given in this appendix is entitled as a Vehicle Handling Supplement. It is intended for use in conjunction with the Collision Performance and Injury Report (CPIR) Long Form. The Supplement was developed for gathering information which could be used to identify vehicle handling factors in an accident. In separating vehicle handling factors from an accident, it is necessary to identify confounding influences which may also be accident causation factors. Thus, the Supplement is divided into sections which encompass:

(1) Environment
(2) Roadway
(3) Vehicle
(4) Operator
(5) Accident Kinematics

The Supplement is assembled in a modular fashion such that parts (or pages) can be added or deleted depending upon the case. For example, while it is clear that the Environmental conditions surrounding two vehicles involved in an accident will almost always be the same, the Roadway conditions could be entirely different--e.g., two vehicles approaching on separate roads. Therefore, if there is interest in the two separate vehicles, a roadway section for each would be prepared. Further, the roadway section is streamlined in other ways. The shoulder and sign sections are set up so as to be applicable to either the right or left shoulder by designating which in the appropriate blank. Two shoulder sections would be necessary if both right and left shoulders are of interest.

The major emphasis in the Vehicle section is on maintenance condition and modifications from original equipment. The identification of the vehicle (except for tires) will be given in the CPIR form. Emphasizing maintenance and modifications is not for

the purpose of assigning accident causation to these factors. (Keep in mind that causation factors relating to original design are the main concern here.) Rather, the purpose is to identify the variations in maintenance and owner modification so that their effect on the "as-new" handling qualities of the vehicle can be assessed. It is anticipated that the accident data acquired by way of the Vehicle Handling Supplement will be used in correlation studies with measured handling data from a set of new vehicles. The variation of the accident-involved vehicle from its measured status will therefore be of prime interest.

Most of the material on the Vehicle is self-explanatory, except perhaps for the following points. A separate page is provided for recording the tread profile of each individual tire. These profiles are to be obtained with a contour gauge like that pictured in Figure 8.11 of Section 8.

It is rather widely believed that the vehicle Operator is a large factor in accident causation. Further, it has been shown that age and sex are two driver characteristics that seem to correlate with accident experience. The specific driver qualities that make age and sex important, however, have never been identified. For example, is it physical strength, stature, mental attitude, experience, combinations thereof, or are there other driver qualities which make age and sex correlate with accident experience. To take another tack, is driver-vehicle matching a factor? Are young people more involved in accidents because they drive more Volkswagens, or are Volkswagens more involved in accidents because they are driven more by young people? Whatever the case (if indeed there is a connection), pinpointing the answer will require as much specific information as possible about driver characteristics. The operator information required in the Supplement is again self-explanatory and is designed to add to information already collected in the CPIR form.

The final three pages in the Supplement deal with Accident Kinematics. The emphasis in this part is a careful analysis of skid marks. On the final page (which can be expanded to several pages for any number of skid marks) each skid mark (numbered serially according to the Accident Schematic) and causative tire are identified. Space is allotted for recording the coordinates of the skid mark curve, and for denoting the angle of striation marks at these coordinates. Space is also allotted for denoting the vehicle motions and driver actions that seemingly correlate with the skid mark information. The information is again supplemental to the CPIR form with the intent that the information would be used in carefully reconstructing the accident by means of computer simulation.

VEHICLE HANDLING SUPPLEMENT

REPORT NO. __ __ __ __ __ __ __ __

CASE VEHICLE _____

SUPPLEMENT INVESTIGATION DATE ____/____/____

INVESTIGATOR _____ CHECKER _____

ENVIRONMENT - AMBIANCE

POPULATION OF GOVERNING JURISDICTION _____

(0) Unknown
(1) Under 2500
(2) 2500-4,999
(3) 5000-9,999
(4) 10,000-24,999
(5) 25,000-49,999
(6) 50,000-99,999
(7) 100,000-249,999
(8) 250,000 and over
(9) N/A

WIND VELOCITY ___ ___ ___ (MPH)

(999) Unknown

WIND DIRECTION ___ ___ ___.

(888) N/A
(999) Unknown

TEMPERATURE ___ ___ ___ °F.

(888) N/A
(999) Unknown

_____ VEHICLE

ROADWAY

SPEED LIMIT ___ ___

(00) Unknown
(99) N/A

SPEED LIMIT TYPE _____

(0) Unknown
(1) Posted
(2) Posted Advisory
(3) Prime Facie
(4) No Limit
(5) Other_____

ROADWAY TYPE[2] _____

(0) Unknown
Rural
(1) Primary Road
(2) Secondary Road
(3) Farm-to-Market
(4) Land Service Road
Urban
(5) Major Arterial Street
(6) Collector Street
(7) Local Street
Rural/Urban
(8) Expressway/Freeway
(9) Other_____

ANCILLARY LANES (Two, at most) _____
_____

(00) Unknown
(01) None
(02) Climbing
(03) Entrance Lane
(04) Exit Lane
(05) Weaving, Mixing Lane
(06) Truck
(07) Frontage Weaving
(08) Service Road
(09) Runaway Lanes
(10) Other_____

ROAD SURFACE TEXTURE _____

(0) Unknown
(1) Smooth
(2) Fine, Rounded
(3) Fine, Gritty
(4) Coarse, Rounded
(5) Coarse, Gritty
(6) Unpaved
(7) Other_____
(8) N/A

SKID NUMBER (40 MPH) ___ ___ ___

(000) Unknown

SKID NUMBER GRADIENT - ___ . ___ ___ per mph

(0.00) Unknown

SKID NUMBER MEASUREMENT METHOD ____
(Two, at most) ____

(0) Unknown
(1) None
(2) Skid Trailer
(3) Other ASTM Force Measuring Device
(4) British Portable Tester
(5) μ Meter
(6) Other Portable Tester
(7) Schonfeld Photo-Interpreation Method
(8) Other Method_____
_____
(9) N/A

POTHOLES [1] ____

DENSITY (Frequency per 25 ft. of One Lane Width) ___ ___ ___

(000) Unknown
(999) N/A

LONGITUDINAL DIMENSION OF LARGEST POTHOLE ____ft. ___ ___in.

(000) Unknown
(999) N/A

LATERAL DIMENSION OF LARGEST POTHOLE ___ft. ___ ___in.

(000) Unknown
(999) N/A

LONGITUDINAL DIMENSION OF SMALLEST POTHOLE ___ft. ___ ___in.

(000) Unknown
(999) N/A

LATERAL DIMENSION OF SMALLEST POTHOLE ___ft. ___ ___in.

(000) Unknown
(999) N/A

[1](0) Unknown (2) No
(1) Yes (3) N/A

[2]See Attached Description of Terms

DEFINITIONS

Primary Road - A highway of first importance (in most states they form a designated system of main highways known as the State System)

Secondary Road - Not of primary importance (and usually not considered a part of the state primary system)

Farm-to-Market - A road outside the primary state highway system which connects farms with towns or primary highways

Land Service Road - A road which is used primarily to give access to land

Major Arterial Street - A class of street which brings traffic to and from the expressway (if any) and serves those major movements of traffic within or through the metropolitan area not served by expressways. Major arterials interconnect principal traffic sources with the city and important rural routes

Collector Street - Serves internal traffic movement within an area of the city and connects with the major arterial system. A collector does not handle long through trips and is not continuous for any great distance.

Local Street - Primary for access to residence, business or other abutting property.

Expressway/Freeway - A divided highway for through traffic with full, or occasionally partial control of access and generally with grade separations at intersections.

ROADWAY (CONT.)

WASHBOARD PATTERN [1]_____

LENGTH BETWEEN PEAKS ___ ___ft. ___ ___in.

(000) Unknown
(999) N/A

PEAK TO VALLEY AMPLITUDE ___ ___in.

(000) Unknown
(999) N/A

TOTAL LENGTH ___ ___ ___ft.

(000) Unknown
(888) Continuous
(999) N/A

MAXIMUM WIDTH ___ ___ft. ___ ___in.

(000) Unknown
(999) N/A

POSITION OF MIDDLE OF PATTERN FROM RIGHT PAVEMENT EDGE ___ ___ft. ___ ___ in.

(000) Unknown
(999) N/A

DEBRIS ON ROADWAY [1]_____

DESCRIBE_____

_____

WARNING RUMBLE STRIPS [1]_____

SPEED BUMPS [1]_____

LANE #1 (RT. LANE)

SUPERELEVATION/CROWN ___.___%

WIDTH ___ ___ft. ___ ___in.

(000) Unknown
(999) N/A

LANE #2

SUPERELEVATION/CROWN ___.___%

WIDTH ___ ___ft. ___ ___in.

(000) Unknown
(999) N/A

LANE #3

SUPERELEVATION/CROWN ___.___%

WIDTH ___ ___ft. ___ ___in.

(000) Unknown
(999) N/A

LANE #4

SUPERELEVATION/CROWN ___.___%

WIDTH ___ ___ft. ___ ___in.

(000) Unknown
(999) N/A

MEDIAN CROSS SECTION ____

(0) Unknown
(1) No Median
(2) Paved, Raised Divider
(3) Paved Median Barrier
(4) Unpaved, Flat
(5) Unpaved, Raised
(6) Unpaved, Depressed
(7) Other_____
(8) N/A

MEDIAN WIDTH __ __ __ft. __ __in.

(000) Unknown
(999) N/A

HORIZONTAL ALIGNMENT ____

(0) Unknown
(1) Tangent
(2) Circular Curve to Left
(3) Circular Curve to Right
(4) Transition Curve to Left
(5) Transition Curve to Right
(6) Combinations of (1)-(5)
(7) Other_____
(8) N/A

CURVATURE (RADIUS) ___ ___,___ ___ ___ft.

(000) Unknown
(999) N/A

[1] (0) Unknown (2) No
(1) Yes (3) N/A

ROADWAY (CONT.)

VERTICAL ALIGNMENT (Two, at most) _____
_____

(0) Unknown
(1) Level
(2) Upgrade
(3) Downgrade
(4) Crest of Hill
(5) Bottom of Valley, Sag
(6) Roller Coaster
(7) Dip
(8) Other_____
(9) N/A

GRADE ___ ___.___%

(00) None
(77) Unknown
(88) Variable
(99) N/A

Crest/Curve TO RIGHT [1] _____

Crest/Curve TO LEFT [1] _____

PAVEMENT EDGE DROP-OFF [1] _____

DEPTH OF DROP ___ ___in.
(00) Unknown
(99) N/A

PAVEMENT PATCHING PRESENT [1] _____

RR GRADE CROSSING [1] _____

LONGITUDINAL PAVEMENT RUTTING [1] _____

MAP CRACKING [1] _____

BLEEDING ASPHALT [1] _____

TRANSVERSE JOINT PUSH-UP [1] _____

LONGITUDINAL PAVEMENT GROOVING [1] _____

TRANSVERSE PAVEMENT GROOVING [1] _____

ESTIMATED WATER DEPTH ON ROAD
(if present) .___ ___in.

(00) Unknown
(99) N/A

UNIFORMITY OF SURFACE COVERING _____

(0) Unknown
(1) None
(2) Continuous
(3) Patchy
(4) Other_____
(5) N/A

LANE MARKINGS PRESENT [1] _____

MARKINGS WORN AWAY [1] _____

NOSE OR FUNNEL MARKINGS MISSING AT EXIT OR ENTRANCE RAMP [1] _____

PAVEMENT WIDTH TRANSITION MARKINGS MISSING [1] _____

ROAD EDGE DELINEATORS MISSING [1] _____

[1] (1) Yes (0) Unknown
(2) No (9) N/A

ROADWAY (CONT.)

DIAGONAL MARKINGS MISSING AT UNDER-PASS, PIER, ABUTMENT, ETC. [1]____

MARKINGS MISSING AT MEDIAN CURB OR ISLAND [1]____

MARKING INSUFFICIENT TO WARN OF APPROACHING INTERCHANGE EXIT OR ENTRANCE RAMP [1]____

INADEQUATE CHANNELING OF TRAFFIC IN ADVANCE OF INTERSECTION [1]____

MARKINGS NOT REFLECTORIZED WHERE NEEDED [1]____

MARKINGS FREQUENTLY COVERED BY ICE, SNOW, DIRT, OR MUD, ETC. [1]____

OTHER MARKING DEFICIENCIES

_____

_____

_____

_____

_____

_____

_____

SIGHT DISTANCE

OBSTRUCTIONS (Two, at most) ____ ____

____ ____

(00) Unknown
(01) None
(02) Hillcrest
(03) Blind Curve
(04) Combined Crest/Curve
(05) Dip
(06) Embankments
(07) Piled Snow
(08) Guardrail
(09) Bridge Rail/Abutment
(10) Foliage, Trees, Natural Growth
(11) Highway Sign
(12) Commercial Sign
(13) Building
(14) Fence
(15) Median Barrier
(16) Other_____
(99) N/A

MINIMUM STOPPING SIGHT DISTANCE ___,___ ___ ___ft.

(0000) Unknown
(8888) Unlimited
(9999) N/A

MINIMUM PASSING SIGHT DISTANCE ___,___ ___ ___ft.

(0000) Unknown
(8888) Unlimited
(9999) N/A

ARTIFICIAL ILLUMINATION ____

(0) Unknown
(1) None
(2) Tungsten
(3) Florescent
(4) Mercury Vapor
(5) Sodium Vapor
(6) Other_____
(9) N/A (daytime)

AVERAGE SCENE LUMINANCE

____ ____ ____ft. candles

(000) Unknown
(999) N/A

[1] (0) Unknown (2) No
(1) Yes (9) N/A

ROADWAY (CONT.)

ILLUMINATION DEFICIENCIES (Two at most)

_____
_____

(0) Unknown
(1) None
(2) Overhead Illumination Inadequate or Missing on High Density Curve
(3) High Density Curve Intersection or Interchange
(4) Lighting Glare
(5) Illumination Intermittant
(6) Other (Be Specific)_____

_____
_____
_____

(7) N/A

INTERSECTION DEFICIENCIES (Three, at most)

_____
_____
_____

(0) Unknown
(1) None
(2) Traffic Signing
(3) Lights
(4) Marking
(5) Signals
(6) Commercial Signing Confusion
(7) Sight Obstructions
(8) Other (Be Specific)_____

_____
_____
_____
_____

(9) N/A

INTERCHANGE DESIGN DEFICIENCIES (Four, at most)

_____
_____
_____
_____

(0) Unknown
(1) None
(2) Inadequate Maneuvering Distance Between Successive Exits
(3) Inadequate Maneuvering Distance Between Entry and Exit Ramps
(4) Entry Lane Too Short for Safe Merging with Traffic
(5) Exit Lane Too Short Requiring Slow Down on Main Roadway
(6) Entry Ramp Curve Not Fitted to Roadway
(7) Exit Ramp Curve Not Fitted to Roadway
(8) Entry Ramp Grade Too Steep
(9) Exit Ramp Grade Too Steep
(10) View of Traffic From Entry Lane Inadequate
(11) Exit and Entry Ramps Too Narrow for Traffic Volume
(12) Ramp Shoulders Too Narrow
(13) Inadequate Warning Distance in Front of Interchange Such That Weaving Length is Too Short
(14) Other_____
(15) N/A

ROADWAY (CONT.)

_____ SHOULDER

SHOULDER TYPE _____

(0) Unknown
(1) No Shoulder
(2) No Shoulder, Curbing
(3) Paved, Flat
(4) Paved, Superelevated
(5) Gravel
(6) Sodded Grass
(7) Unimproved
(8) Other_____
(9) N/A

SHOULDER WIDTH ___ ___ft. ___ ___in.

(00) Unknown
(99) N/A

CURB PROFILE (If Present)

ADJACENT SHOULDER ELEMENTS

Ditch	[1] ____
Fence	[1] ____
Cut Section	[1] ____
Fill Section	[1] ____
Drainage Culvert	[1] ____
Guardrail	[1] ____
Utility Poles	[1] ____
Trees	[1] ____
Buildings	[1] ____
Parked Cars	[1] ____
Water Body	[1] ____
Impact Attenuator	[1] ____
Signs	[1] ____

Other_____

_____

_____

[1] (0) Unknown
(1) Yes
(2) No
(9) N/A

ROADWAY (CONT.)

____SHOULDER SIGNS (IN ORDER FROM ONE MILE UPSTREAM OF ACCIDENT SITE)

SIGN NO.	ILLUSTRATIVE DRAWING	
— —		Possible Accident Causation Factor[1] ____ Message Type[2] ____ Illumination[3] ____ Content/ Arrangement[4] ____ Visibility[5] ____ ____ Advance Warning[6] ____ Applicable Code from MUTCD ____ ____ ____ ____

REMARKS_____

_____

_____

SIGN NO.	ILLUSTRATIVE DRAWING	
— —		Possible Accident Causation Factor[1] ____ Message Type[2] ____ Illumination[3] ____ Content/ Arrangement[4] ____ Visibility[5] ____ ____ Advance Warning[6] ____ Applicable Code from MUTCD ____ ____ ____ ____

REMARKS_____

_____

_____

SIGNING KEY

[1]
(0) Unknown
(1) Yes
(2) No
(3) N/A

[2]MESSAGE TYPE

(0) Unknown
(1) Permanent
(2) Manually Variable
(3) Automatically Variable
(4) Other_____
(5) N/A

[3]ILLUMINATION

(0) Unknown
(1) Unlighted
(2) Externally Lighted
(3) Luminescent Panels
(4) Luminous Tube Message
(5) Other_____
(6) N/A

[4]CONTENT OR ARRANGEMENT

(0) Unknown
(1) Sign Too Small
(2) Sign Letters Too Small or Too Narrow
(3) Sign Legend Components Confusing
(4) Sign Too Wordy to be Read Quickly
(5) Confusion Caused by Too Many Signs
(6) Insufficient Differentiation Between Major and Minor Signs
(7) Other_____
(8) N/A

[5]VISIBILITY

(00) Unknown
(01) Sign Down
(02) Sign Frequently Obscured by Dirt, Snow or Ice
(03) Sign Obscured by Foliage
(04) Sign Obscured by Roadside Structure
(05) Sign Obscured by Other Sign
(06) Sign Leaning - Difficult to Read
(07) Sign Too Low - Difficult to Read
(08) Sign Not Reflectorized
(09) Sign Not Lit or Inadequately Lighted
(10) Other_____
(11) N/A

[6]ADVANCE WARNING

(0) Unknown
(1) Inadequate Advance Warning of Interchange Ahead
(2) Inadequate Advance Warning of Curve Ahead
(3) Inadequate Advance Warning of Bridge Ahead
(4) Inadequate Advance Warning of Change from Divided to Undivided Highway
(5) Inadequate Advance Warning of Change in Number of Lanes
(6) Inadequate Advance Warning of Low Underpass or Tunnel Clearance
(7) Inadequate Advance Warning of Steep Grade
(8) Other_____
(9) N/A

GENERAL

FUEL TANK CAPACITY ____ ____gal.

FUEL TANK LEVEL

(0) Unknown
(1) No Fuel Tank
(2) Empty
(3) 0 to < 1/4
(4) 1/4 to < 1/2
(5) 1/2 to < 3/4
(6) 3/4 to < Full
(7) Full
(8) N/A

AREAS OF BODY RUST (If Any):

_____

_____

_____

_____

_____

EVIDENCE OF PERIODIC INSPECTION:

Inspection Sticker [1] ____

State of Inspection ____ ____

(00) Unknown
(99) N/A

Date of Inspection ___ ___/___ ___

(0000) Unknown
(9999) N/A

[1] (0) Unknown
(1) Yes
(2) No
(3) N/A

CARGO

ITEM #1 _____

_____

Wt. [2] ___ ___ ___lb. Pos. [3] ___ ___

ITEM #2 _____

_____

Wt. [2] ___ ___ ___lb. Pos. [3] ___ ___

ITEM #3 _____

_____

Wt. [2] ___ ___ ___lb. Pos. [3] ___ ___

ITEM #4 _____

_____

Wt. [2] ___ ___ ___lb. Pos. [3] ___ ___

[2] (000) Unknown
(999) N/A

[3] (00) Unknown
(99) N/A

ENGINE

ENGINE DISPLACEMENT (If Applicable)

___ ___ ___cu.in.

(000) Unknown
(999) N/A

STYLE

(0) Unknown
(1) Straight
(2) V
(3) Opposed
(4) Rotary (e.g. Wankle)
(5) Turbine
(6) Electric
(7) Other_____

_____

(8) N/A

FUEL (If Applicable)

(0) Unknown
(1) None
(2) Gasoline
(3) Fuel Oil or Kerosene (Diesel)
(4) Propane
(5) Other_____

_____

(6) N/A

FUEL FEED SYSTEM (If Applicable)

(0) Unknown
(1) None
(2) Carburetor
(3) Fuel Injection
(4) Other_____

_____

(5) N/A

NUMBER OF CARBURETORS (If Applicable)

_____ _____

VENTURI PER CARBURETOR _____

ENGINE MODIFICATIONS_____

_____

_____

_____

_____

_____

_____

_____

_____ VEHICLE

TIRES	LF	LR	RF	RR
Ply Rating	_____ _____	_____ _____	_____ _____	_____ _____
Construction[2]	_____	_____	_____	_____
Inflation Pressure	_____ _____	_____ _____	_____ _____	_____ _____
Puncture Repair[1]	_____	_____	_____	_____
Tube in Tubeless Tire[1]	_____	_____	_____	_____
Retread[1]	_____	_____	_____	_____
IF FLAT: Description of rim damage (i.e., enough for air loss), if applicable	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____
Description of tire damage (include towing damage after accident) if applicable	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____	_____ _____ _____ _____
Type of Tire Damage[3] (Four, at most)	_____	_____	_____	_____
Location of Tire Damage[4] (Four, at most)	_____	_____	_____	_____

RECOMMENDED INFLATION PRESSURES: FRONT___ ___psi REAR___ ___psi

(See Next Page for Code)

[1] (0) Unknown
(1) Yes
(2) No
(3) N/A

[2]CONSTRUCTION

(0) Unknown
(1) Bias
(2) Bias/Belted
(3) Radial
(4) Other
(5) N/A

[3]TIRE DAMAGE

(0) Unknown
(1) Object Embedded
(2) Roughly Circular Hole
(3) Longitudinal Tear
(4) Tread Separation
(5) Broken Bead
(6) Other
(7) N/A

[4]LOCATION OF DAMAGE

(0) Unknown
(1) Tread Face
(2) Inner Sidewall
(3) Outer Sidewall
(4) Bead
(5) Other
(6) N/A

_____ VEHICLE

TIRES (CONT.)

TREAD PROFILE - LF

_____ VEHICLE

TIRES (CONT.)

TREAD PROFILE - LR

_____ VEHICLE

TIRES (CONT.)

TREAD PROFILE - RF

_____ VEHICLE

TIRES (CONT.)

TREAD PROFILE - RR

BRAKES

GROSS MECHANICAL CONDITION AFTER ACCIDENT: FRONT_____

REAR_____

(0) Unknown
(1) Functional
(2) Non-Functional, Crash Damage
(3) Non-Functional, No Crash Damage
(4) Other_____
(5) N/A

BRAKE FLUID RESERVOIR LEVEL

FRONT_____

REAR_____

(0) Unknown
(1) Empty
(2) 0 to < 1/4
(3) 1/4 to < 1/2
(4) 1/2 to < 3/4
(5) 3/4 to < Full
(6) Full
(7) N/A

DRUM/ROTOR CONDITION (Three, at most)

LF	LR	RF	RR
____	____	____	____
____	____	____	____
____	____	____	____

(00) Unknown
(01) No Defects
(02) No Wear
(03) Light Wear
(04) Moderate Wear
(05) Heavy Wear
(06) Scoring
(07) Pitting
(08) Uneven Wear
(09) Cracks or Checks from Over-Heating
(10) Discoloration from Over-Heating
(11) Runout (Warping) of Rotor
(12) Other_____

(13) N/A

PAD/LINING CONDITION (Three, at most)

LF	LR	RF	RR
____	____	____	____
____	____	____	____
____	____	____	____

(00) Unknown
(01) No Defects
(02) No Lining Wear
(03) Light Wear
(04) Moderate Wear
(05) Heavy Wear
(06) Lining Worn Away
(07) Scoring
(08) Pitting
(09) Uneven Wear
(10) Other_____
(11) N/A

PRESENCE OF CONTAMINANTS ON PADS/LINING

LF	LR	RF	RR
[1] ____	[1] ____	[1] ____	[1] ____

TYPE OF CONTAMINANT (Two, at most)

LF	LR	RF	RR
____	____	____	____
____	____	____	____

(0) Unknown
(1) None
(2) Grease
(3) Brake Fluid
(4) Dust, Dirt
(5) Water
(6) Other_____
(7) N/A

VISUAL PRESENCE OF LEAKS IN:

WHEEL CYLINDERS

LF	LR	RF	RR
[1] ____	[1] ____	[1] ____	[1] ____

MASTER CYLINDERS Front [1] ____

Rear [1] ____

[1] (0) Unknown (2) No
(1) Yes (3) N/A

BRAKES (CONT.)

EVIDENCE OF DEFICIENCIES IN HYDRAULIC LINES

_____

(0) Unknown
(1) No Defects
(2) Impact Damage
(3) Pre-Impact Damage
(4) Other_____
(5) N/A

EVIDENCE OF OTHER DEFICIENCIES—DRUM BRAKES (Two, at most)

LF	LR	RF	RR
____	____	____	____
____	____	____	____

(0) Unknown
(1) None
(2) Rusty Wheel Cylinders
(3) Rusty Cylinder Piston
(4) Scored Cylinder Piston
(5) Missing Shoe Return Spring
(6) Other_____

_____

(7) N/A

EVIDENCE OF RECENT REBUILD/REPLACEMENT

LF	LR	RF	RR
[1] ____	[1] ____	[1] ____	[1] ____

TYPE OF EVIDENCE (Three, at most)

LF	LR	RF	RR
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

(00) Unknown
(01) None
(02) Brake Fluid on Tires or Rims From Bleeding
(03) New Pads
(04) Other_____

DRUM BRAKES ONLY

(05) Clean Drum Interior
(06) Evidence of Machining on Inside of Brake Drum
(07) Asbestos Shim Under Pad or Oversized Pad
(08) New Shoe Return Spring
(09) Eccentric Adjustment of Shoe at Maximum Position
(10) Other_____

_____

(11) N/A

PEDAL TRAVEL:

First Pump ____ ____(in.)
Second Pump ____ ____(in.)
Third Pump ____ ____(in.)

PEDAL RESISTANCE ____

(0) Unknown
(1) None
(2) Firm
(3) Spongy
(4) Gradual Travel Under Moderate Pressure
(5) Other_____

_____

_____

_____

(6) N/A

PARKING BRAKE ____

(0) Unknown
(1) Not Equipped
(2) ON Position
(3) OFF Position
(4) Partly ON, But Not Engaged
(5) Other_____

_____

(6) N/A

[1] (0) Unknown (2) No
(1) Yes (3) N/A

SUSPENSION

GROSS MECHANICAL CONDITION AFTER ACCIDENT: _____

(0) Unknown
(1) Functional
(2) Non-Functional, Crash Damage
(3) Non-Functional, No Crash Damage
(4) Other_____

_____

(5) N/A

SPECIFIC OBSERVATIONS:

Visible Ball Joint Wear [1] ____

Visible Shock Absorber Wear (Bleeding, Excessive Oscillation) [1] ____

Evidence of Suspension Bottoming [1] ____

Evidence of Wheel Strikes in Wheel Wells [1] ____

Evidence of Recent Lubrication [1] ____

Lubrication Sticker [1] ____

Date on Sticker ____ ____/____ ____

Mileage on Sticker

___ ___ ___,___ ___ ___ ___

Broken Springs [1] ____

Broken Torsion Bar [1] ____

Broken Suspension Arms [1] ____

Describe Observations _____

_____

_____

[1] (0) Unknown (2) No
(1) Yes (9) N/A

TYPE OF REPLACEMENT SHOCKS

Front _____

Rear _____

(0) Unknown
(1) Original Shocks
(2) Oversized
(3) Air Shocks
(4) Heavy Duty
(5) Load Levelers
(6) No Shocks Present
(7) Other_____

_____

(8) N/A

MODIFICATIONS BY OWNER (Three, at most)

_____, _____, _____

(0) Unknown
(1) None
(2) Raised Front
(3) Lowered Front
(4) Raised Rear
(5) Lowered Rear
(6) Rubber Helper Springs
(7) Shackles, Blocks, Traction Bars, et.
(8) Other_____

_____

(9) N/A

STEERING

GROSS MECHANICAL CONDITION AFTER ACCIDENT: _____

(0) Unknown
(1) Functional
(2) Non-Functional, Crash Damage
(3) Non-Functional, No Crash Damage
(4) Other_____

_____

(5) N/A

SPECIFIC OBSERVATIONS:

Visible Linkage Joint Wear [1] _____

Bent or Broken Linkage Elements [1] _____

Evidence of Improper
Toe In [1] _____
Caster [1] _____
Camber [1] _____

Presence of Front Wheel Balance Weights [1] _____

Presence of Rear Wheel Balance Weights [1] _____

Evidence of Steering System Binding [1] _____

Presence of Loose Wheel Lug Nuts [1] _____

Worn or Loose Wheel Bearings [1] _____

Evidence of Inadequate Wheel Bearing Lubrication [1] _____

Evidence of Recent Repair Work [1] _____

[1] (0) Unknown (2) No
(1) Yes (3) N/A

IF POWER ASSIST:

RESERVOIR LEVEL _____

(0) Unknown
(1) Empty
(2) 0 to < 1/4
(3) 1/4 to < 1/2
(4) 1/2 to < 3/4
(5) 3/4 to < Full
(6) Full
(7) N/A

BELT INTEGRITY (Two, at most) ___, ___

(0) Unknown
(1) Intact
(2) All Impact Damage
(3) Pre-Impact Rupture or Sever
(4) Pre-Impact Slippage
(5) Heavy Wear
(6) Cracking
(7) Other_____

_____

(8) N/A

STEERING WHEEL DIAMETER ___ ___(in.)

(00) Unknown
(99) N/A

FREEPLAY AT PERIMETER OF STEERING WHEEL ___ ___(in.)

(00) Unknown
(99) N/A

ENGINE RUNNING FOR FREEPLAY MEASUREMENT [1] _____

MODIFICATION OF STEERING WHEEL BY OWNER (Three, at most) ___, ___, ___

(0) Unknown
(1) None
(2) Non-OE Steering Wheel
(3) Wheel Knobs
(4) Rim Covering
(5) Other_____

_____

(6) N/A

DRIVE TRAIN

GROSS MECHANICAL CONDITION AFTER ACCIDENT _____

(0) Unknown
(1) Functional
(2) Non-Functional, Crash Damage
(3) Non-Functional, No Crash Damage
(4) Other_____

_____

(5) N/A

SPECIFIC OBSERVATIONS:

Visible Transmission Leakage [1] ____

Visible Differential Leakage [1] ____

Visible Drive Shaft Universal Joint Wear:

Fore/Aft Play [1] ____

Lateral Play [1] ____

Non-Slip Differential [1] ____

IF AUTOMATIC:

Reservoir Level ____

(0) Unknown
(1) Empty
(2) 0 to < 1/4
(3) 1/4 to < 1/2
(4) 1/2 to < 3/4
(5) 3/4 to < Full
(6) Full
(7) N/A

TRANSMISSION SELECTOR POSITION ____

(0) Unknown
(1) Neutral
(2) Drive
(3) Drive L1
(4) Drive L2
(5) Reverse
(6) Park
(7) Other_____

_____

(8) N/A

IF MANUAL:

Number of Forward Gear Shift Positions ____

Shift Lever Position ____

(00) Unknown
(01) Neutral
(02) First
(03) Second
(04) Third
(05) Fourth
(06) Fifth
(07) Reverse
(08) Overdrive
(09) Other_____

_____

(10) N/A

[1] (0) Unknown (2) No
(1) Yes (3) N/A

VISIBILITY

TINTED WINDSHIELD [1] ____

TINTED SIDE GLASS [1] ____

WINDSHIELD CLEAN [1] ____

APPROXIMATE WINDOW AREA OBSCURED BY STICKERS:

Front	___ ___ ___	sq. in.
Rear	___ ___ ___	sq. in.
Right Side	___ ___ ___	sq. in.
Left Side	___ ___ ___	sq. in.

(000) Unknown
(999) N/A

APPROXIMATE % OF WINDOW AREA OBSCURED BY FROST CONDENSATION:

Front	___ ___ ___	sq. in.
Rear	___ ___ ___	sq. in.
Right Side	___ ___ ___	sq. in.
Left Side	___ ___ ___	sq. in.

(000) Unknown
(999) N/A

WINDSHIELD WIPER SWITCH POSITION ____

(0) Unknown
(1) Not Equipped
(2) On
(3) Off
(4) Not Working
(5) Other_____
(6) N/A

LEFT WIPER:

Wiper Present [1] ____

Anti-Lift Foil Present [1] ____

Blade Scoring Windshield [1] ____

Condition (Two, at most) [2] ____

[2] ____

[2] (0) Unknown
(1) No Defects
(2) Rubber Blade Worn
(3) Rubber Blade Hard or Cracked
(4) Rubber Blade Missing
(5) Other_____

_____

(6) N/A

RIGHT WIPER:

Wiper Present [1] ____

Anti-Lift Foil Present [1] ____

Blade Scoring Windshield [1] ____

Condition (Two, at most) [2] ____

[2] ____

MIRROR EQUIPMENT

Internal [1] ____

Day/Night Feature [1] ____

Left Exterior [1] ____

Right Exterior [1] ____

Exterior Mirror Extensions

Right [1] ____

Left [1] ____

HEADLAMPS:

Right [1] ____

Left [1] ____

IF ON ____

(0) Unknown
(1) High Beam
(2) Low Beam
(3) N/A

LENSE CONDITION

Right [3] ____

Left [3] ____

[3] (0) Unknown
(1) Clean
(2) Dirty
(3) Partly Obscured
(4) Broken
(5) Not Present
(6) Other_____

_____

(7) N/A

[1] (0) Unknown (2) No
(1) Yes (3) N/A

VISIBILITY (CONT.)

TAIL LAMPS:

Right	1____
Left	1____

LENSE CONDITION

Right	3____
Left	3____

FRONT PARKING LIGHTS

Right	1____
Left	1____

LENSE CONDITION

Right	3____
Left	3____

REAR BRAKE LIGHTS

Right	____
Left	____

(0) Unknown
(1) Working
(2) Not Working
(3) Not Equipped
(4) Other_____
(5) N/A

LENSE CONDITION

Right	3____
Left	3____

SIDE REFLECTORS

LF	3____
LR	3____
RF	3____
RR	3____

EXHAUST SYSTEM

GROSS CONDITION AFTER ACCIDENT ____

(0) Unknown
(1) Functional
(2) Non-Functional, Crash Damage
(3) Non-Functional, No Crash Damage
(4) Other_____

_____

(5) N/A

ELEMENT	NO.	LOCATION[2]	CONDITION[3]
Exhaust Pipe	1	_____	_____
	2	_____	_____
	3	_____	_____
Muffler	1	_____	_____
	2	_____	_____
	3	_____	_____
Tail Pipe	1	_____	_____
	2	_____	_____
	3	_____	_____
Resonator	1	_____	_____
	2	_____	_____
	3	_____	_____

[2]LOCATION

(0) Unknown
(1) None Present
(2) Left Side (Looking from Rear to Front of Vehicle)
(3) Right Side
(4) Middle
(5) Other_____
(6) N/A

[3]CONDITION

(0) Unknown
(1) Intact
(2) Visible Holes
(3) Other_____
(4) N/A

HEATER/DEFROSTER/AIR CONDITIONING SYSTEMS

GROSS CONDITION AFTER ACCIDENT:

Windshield Defroster ____

Rear Window Defroster ____

Air Conditioner ____

(0) Unknown
(1) Functional
(2) Non-Functional, Crash Damage
(3) Non-Functional, No Crash Damage
(4) Not Equipped
(5) Other
(6) N/A

Explanation, if needed_____

_____

_____

SWITCH POSITION:

Heater [1] ____

Windshield Defroster [1] ____

Rear Window Defroster [1] ____

Air Conditioner [1] ____

FAN POSITION:

Heater ____

Windshield Defroster ____

Rear Window Defroster ____

Air Conditioner ____

(0) Unknown
(1) No Separate Fan Switch
(2) Low
(3) Medium
(4) High
(5) Maximum
(6) Other
(7) N/A

OTHER ACCESSORIES

Radio [1] ____

Tape Deck [1] ____

[1] (0) Unknown
(1) On
(2) Off
(3) N/A

OPERATOR

REACH (ARMPIT TO FINGERTIP)[2]

___ ___in.

ELBOW TO FINGERTIP[2] ___ ___in.

IN SEAM[2] ___ ___in.

KNEE TO HEEL[2] ___ ___in.

GRIP STRENGTH[3] ___ ___ ___Kg.

PEDAL FORCE STRENGTH[3] ___ ___ ___lb.

REACTION TIME:

Simple[3] ___.___ ___sec.

Binary Decision[3] ___.___ ___sec.

VISION ____

(0) Unknown
(1) 20/20 Both Eyes Uncorrected
(2) 20/20 Both Eyes Corrected
(3) Near Sighted, One Eye
(4) Near Sighted, Both Eyes
(5) Far Sighted, One Eye
(6) Far Sighted, Both Eyes
(7) Other_____

_____

(8) N/A

CORRECTIVE LENSES WORN [1]____

[1] (0) Unknown (2) No
(1) Yes (3) N/A

[2] (00) Unknown
(99) N/A

[3] (000) Unknown
(999) N/A

HOURS SINCE LAST MEAL[2] ___ ___

HOURS SINCE LAST SLEEP[2] ___ ___

HOURS SLEPT PREVIOUS NIGHT/DAY[2] ___ ___

EDUCATION LEVEL ATTAINED ____

(00) Unknown
(01) No Formal Education
(02) 8 Years or Less
(03) > 8 Yr., But < 12 Yr.
(04) High School Diploma or Equivalent
(05) Jr. College, Trade School Degree, or Equivalent
(06) Bachelor's Degree or Equivalent
(07) Master's, Doctor's, or Other Professional Degree
(08) Presently Enrolled in High School
(09) Presently Enrolled in College
(10) Other_____

_____

(11) N/A

DRIVER'S LICENSE TYPE (Three, at most)

____
____
____

(0) Unknown
(1) Automobile Operator
(2) Cycle
(3) Chauffeur
(4) Learner's Permit
(5) Other Special Restrictive Permit
(6) No License
(7) Other_____

_____

(8) N/A

_____ VEHICLE

OPERATOR (CONT.)

LICENSE STATUS (Three, at most) ____ ____ ____

(00) Unknown
(01) Valid, Restriction Compliance Unknown
(02) Valid, Compliance with Restrictions, or No Restrictions
(03) Valid, Non-Compliance with Restrictions
(04) Expired (Not Renewed)
(05) Suspended (Reason Unknown)
(06) Suspended (Driver Violation)
(07) Suspended (by Financial Responsibility Laws)
(08) Revoked
(09) Never Had a License
(10) Under Age, No License
(11) Valid (This State) But Suspended/ Revoked Elsewhere
(12) No License, Reason Unknown
(13) Other_____
_____
(14) N/A

LICENSE RESTRICTIONS (Three, at most) ____ ____ ____

(0) Unknown
(1) No Restriction
(2) Corrective Lenses
(3) Mechanical Aid
(4) Prosthetic Aid
(5) Automatic Transmission
(6) OSR Mirror
(7) Limit Drive
(8) Other_____
(9) N/A

NUMBER OF YEARS DRIVING ____ ____

(00) Unknown
(99) N/A

YEARLY MILEAGE EXPOSURE (ESTIMATE):

Urban ___ ___,___ ___ ___
Rural ___ ___,___ ___ ___

(00000) Unknown
(99999) N/A

CITY OF PRIMARY EXPOSURE, IF APPLICABLE

_____, _____
City State

OWNER OF VEHICLE ____

(0) Unknown
(1) Vehicle Driver
(2) Passenger - Relative
(3) Passenger - Friend
(4) Relative - Not Passenger
(5) Friend - Not Passenger
(6) Company or Business Vehicle
(7) Public or Police Vehicle
(8) Rented Vehicle
(9) Other_____

MONTHS DRIVING VEHICLE ____ ____ ____

(000) Unknown
(999) N/A

TOTAL MILES OF EXPOSURE IN VEHICLE

___ ___ ___,___ ___ ___

(000000) Unknown
(999999) N/A

PROXIMITY OF ACCIDENT TO TRIP ORIGIN

___ ___ ___mi.

(000) Unknown
(999) N/A

ESTIMATED ELAPSED TIME FROM TRIP ORIGIN UNTIL ACCIDENT

___ ___hr. ___ ___min.

(0000) Unknown
(9999) N/A

_____ VEHICLE

OPERATOR (CONT.)

PLANNED LENGTH OF TRIP:

Time Period ___ ___hr. ___ ___min.

(0000) Unknown
(9999) N/A

Distance ___ ___ ___mi.

(000) Unknown
(999) N/A

PURPOSE OF TRIP_____

_____

_____

_____

_____

RELATION OF OPERATOR TO PASSENGERS

Passenger 01____		05____
	02____	06____
	03____	07____
	04____	08____

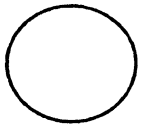
(0) Unknown
(1) Immediate Family
(2) Related, Not Immediate Family
(3) Friend
(4) No Relation or Friendship
(5) Other
(6) N/A

ACCIDENT SCHEMATIC

CASE VEHICLE (A): _____

OTHER VEHICLE (B): _____

THIRD VEHICLE (C): _____



NORTH

ACCIDENT DESCRIPTION: _____

1. Draw in and label skid marks serially
2. Use road station and road edge as coordinate system

ACCIDENT KINEMATICS

Number of Separate Skid Marks: Pre-Crash_____ Post-Crash_____

Description of Reference Point (R.P.) for Skid Mark Coordinates_____

_____

_____

_____

_____

CLASS OF VEHICLE MOTION ____

(0) Unknown
(1) Deceleration, Wheels-Locked Skid
(2) Yawing Skid
(3) Acceleration Skid
(4) Yawing and Deceleration Skid
(5) Yawing and Acceleration Skid
(6) Out-of-Control Spin-Out
(7) Out-of-Control Plow-Out
(8) Other
(9) N/A

PROBABLE DRIVER ACTION ____

(0) Unknown
(1) None
(2) Cornering
(3) Braking
(4) Accelerating
(5) Cornering and Braking
(6) Cornering and Accelerating
(7) Out-of-Control
(8) Other
(9) N/A

SKID MARK COORDINATES

Skid Mark Number_____ Causative Tire_____

Road Station (with Respect to R.P.)	Skid Mark Coordinate (with Respect to Road Edge)	Striation Mark Angle (if present)	[1]Class of Vehicle Motion	[1]Probable Driver Action

[1]See Cue Codes, Previous Page

APPENDIX E

SUPPLEMENTAL DATA ON RELATIONSHIPS BETWEEN VEHICLE HANDLING PARAMETERS (AND INDICES) AND ACCIDENT DESCRIPTORS

The information contained in this appendix consists of plots of vehicle handling parameter and index values as a function of accident frequencies. The plots are supplemental to those given in Section 7.3. Unlike those in Section 7.3, however, the plots presented here show no consistent trends between increasing values of vehicle handling parameters (and indices) and accident experience. The purpose of including the plots here is for completeness in showing both positive and negative results.

The statistics shown represent that percentage of accidents of a particular type as compared to the total number of accidents occurring for vehicles with a particular parameter or index value. Again it should be cautioned that with existing data, and hence the analysis limitations that arise therefrom, neither the existence nor lack of an apparent relationship can be considered as a definitive finding.

For the various vehicle handling parameters and indices, one set of plots is grouped according to accidents occurring on curves, under wet conditions, on curves under wet conditions, and those involving skidding. These are termed set No. 1 descriptors. Another set of plots is grouped according to accidents involving rollover, avoidance maneuvers, female drivers, and vehicles with more than one occupant. These are termed set No. 2 descriptors. A complete list of the plots is given in Table E.1.

Table E.1

Figure	Title
E.1	Overall Height vs. Set No. 1 Descriptors
E.2	Overall Height vs. Set No. 2 Descriptors
E.3	Manufacturer's Specified Front Tire Pressure vs. Set No. 1 Descriptors
E.4	Manufacturer's Specified Front Tire Pressure vs. Set No. 2 Descriptors
E.5	Manufacturer's Specified Rear Tire Pressure vs. Set No. 1 Descriptors
E.6	Manufacturer's Specified Rear Tire Pressure vs. Set No. 2 Descriptors
E.7	Percent Braking Power in Front Wheels vs. Set No. 1 Descriptors
E.8	Percent Braking Power in Front Wheels vs. Set No. 2 Descriptors
E.9	Brake Line Pressure @ 100 lb Pedal Force vs. Set No. 1 Descriptors
E.10	Brake Line Pressure @ 100 lb Pedal Force vs. Set No. 2 Descriptors
E.11	Overall Manual Steering Gear Ratio vs. Set No. 1 Descriptors
E.12	Overall Manual Steering Gear Ratio vs. Set No. 2 Descriptors
E.13	Overall Power Steering Gear Ratio vs. Set No. 1 Descriptors
E.14	Overall Power Steering Gear Ratio vs. Set No. 2 Descriptors
E.15	Side Window Glass Area vs. Set No. 1 Descriptors
E.16	Side Window Glass Area vs. Set No. 2 Descriptors
E.17	Percent Front Passenger Load on Front Axle vs. Set No. 1 Descriptors
E.18	Percent Front Passenger Load on Front Axle vs. Set No. 2 Descriptors
E.19	Percent Rear Passenger Load on Front Axle vs. Set No. 1 Descriptors
E.20	Percent Rear Passenger Load on Front Axle vs. Set No. 2 Descriptors

Table E.1 (Cont.)

Figure	Title
E.21	Non-Dimensional I_z vs. Set No. 1 Descriptors
E.22	Non-Dimensional I_z vs. Set No. 2 Descriptors
E.23	Weight Distribution vs. Set No. 1 Descriptors
E.24	Weight Distribution vs. Set No. 2 Descriptors
E.25	Brake Torque Imbalance vs. Set No. 1 Descriptors
E.26	Brake Torque Imbalance vs. Set No. 2 Descriptors
E.27	Zero Speed Path Curvature Gain vs. Set No. 1 Descriptors
E.28	Zero Speed Path Curvature Gain vs. Set No. 2 Descriptors
E.29	Static Margin - Empty vs. Set No. 1 Descriptors
E.30	Static Margin - Empty vs. Set No. 2 Descriptors
E.31	Roll Compliance - Empty vs. Set No. 1 Descriptors
E.32	Roll Compliance - Empty vs. Set No. 2 Descriptors
E.33	Roll Compliance - Loaded vs. Set No. 1 Descriptors
E.34	Roll Compliance - Loaded vs. Set No. 2 Descriptors
E.35	Steering Sensitivity - Loaded vs. Set No. 1 Descriptors
E.36	Steering Sensitivity - Loaded vs. Set No. 2 Descriptors
E.37	Yaw Sensitivity - Empty vs. Set No. 1 Descriptors
E.38	Yaw Sensitivity - Empty vs. Set No. 2 Descriptors
E.39	Yaw Sensitivity - Loaded vs. Set No. 1 Descriptors
E.40	Yaw Sensitivity - Loaded vs. Set No. 2 Descriptors
E.41	Characteristic Speed - Empty vs. Set No. 1 Descriptors
E.42	Characteristic Speed - Empty vs. Set No. 2 Descriptors
E.43	Characteristic Speed - Loaded vs. Set No. 1 Descriptors
E.44	Characteristic Speed - Loaded vs. Set No. 2 Descriptors
E.45	Total Understeer - Empty vs. Set No. 1 Descriptors
E.46	Total Understeer - Empty vs. Set No. 2 Descriptors
E.47	Total Understeer - Loaded vs. Set No. 1 Descriptors
E.48	Total Understeer - Loaded vs. Set No. 2 Descriptors

Table E.1 (Cont.)

Figure	Title
E.49	Acceleration Time, 0-60 mph vs. Set No. 1 Descriptors
E.50	Acceleration Time, 0-60 mph vs. Set No. 2 Descriptors
E.51	Acceleration Time, Quarter Mile vs. Set No. 1 Descriptors
E.52	Acceleration Time, Quarter Mile vs. Set No. 2 Descriptors
E.53	Speed at End of Quarter Mile vs. Set No. 1 Descriptors
E.54	Speed at End of Quarter Mile vs. Set No. 2 Descriptors
E.55	Stopping Distance From 30 mph vs. Set No. 1 Descriptors
E.56	Stopping Distance From 30 mph vs. Set No. 2 Descriptors
E.57	Stopping Distance From 60 mph vs. Set No. 1 Descriptors
E.58	Stopping Distance From 60 mph vs. Set No. 2 Descriptors

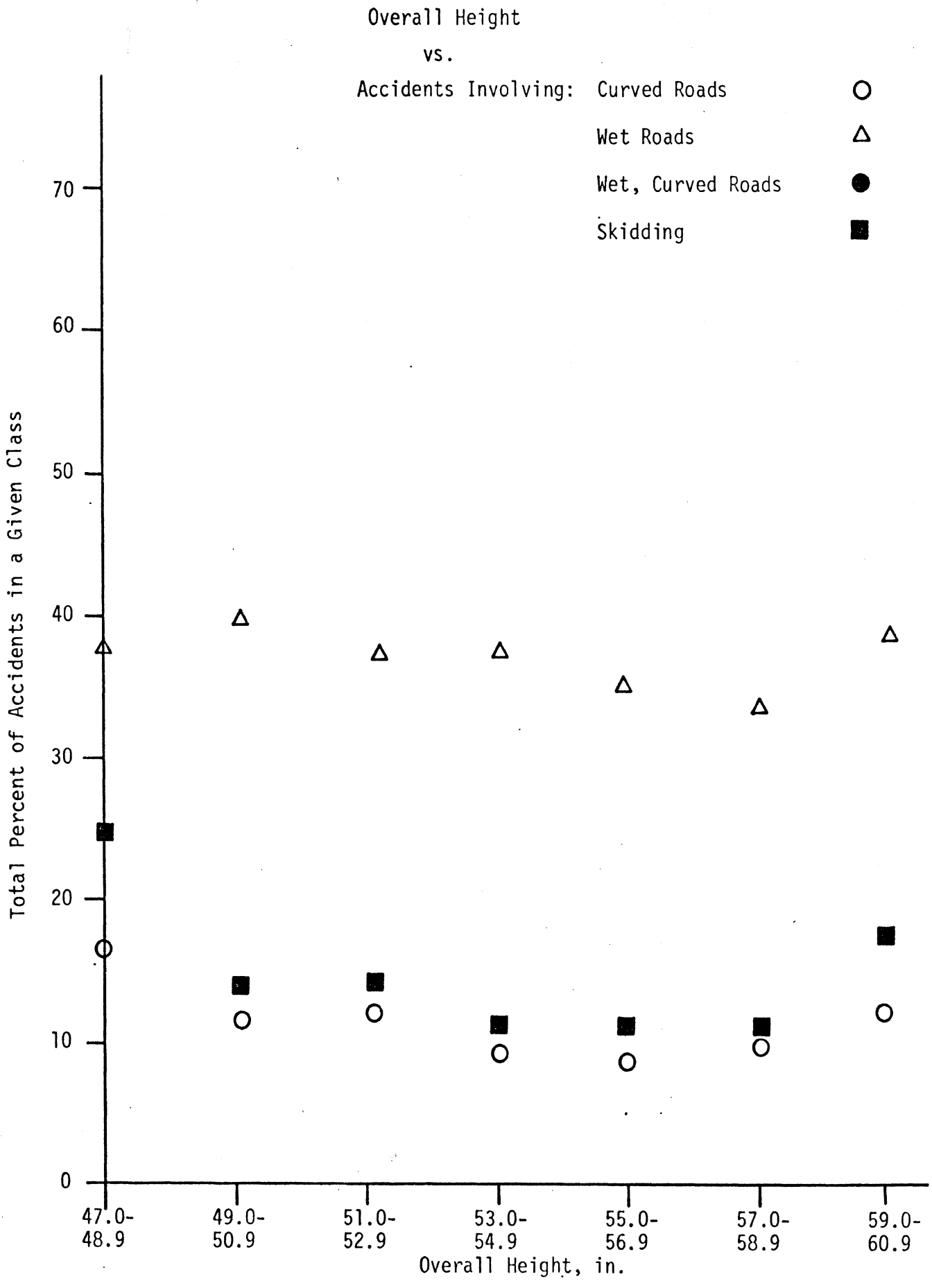

Overall Height
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Total Percent of Accidents in a Given Class
0
10
20
30
40
50
60
70
47.0-48.9
49.0-50.9
51.0-52.9
53.0-54.9
55.0-56.9
57.0-58.9
59.0-60.9
Overall Height, in.

Figure E.1

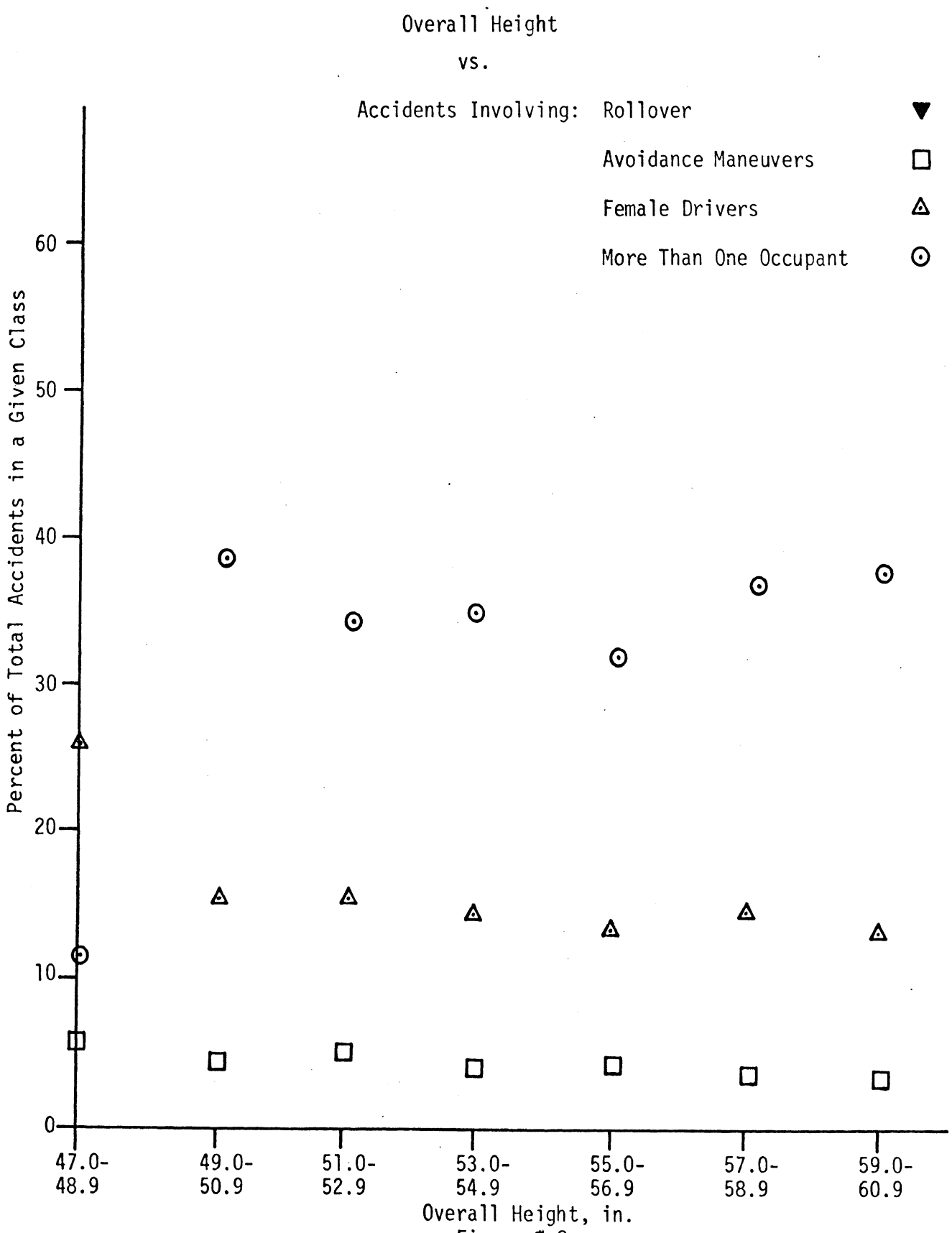

Overall Height
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
47.0-
48.9
49.0-
50.9
51.0-
52.9
53.0-
54.9
55.0-
56.9
57.0-
58.9
59.0-
60.9
Overall Height, in.

Figure E.2

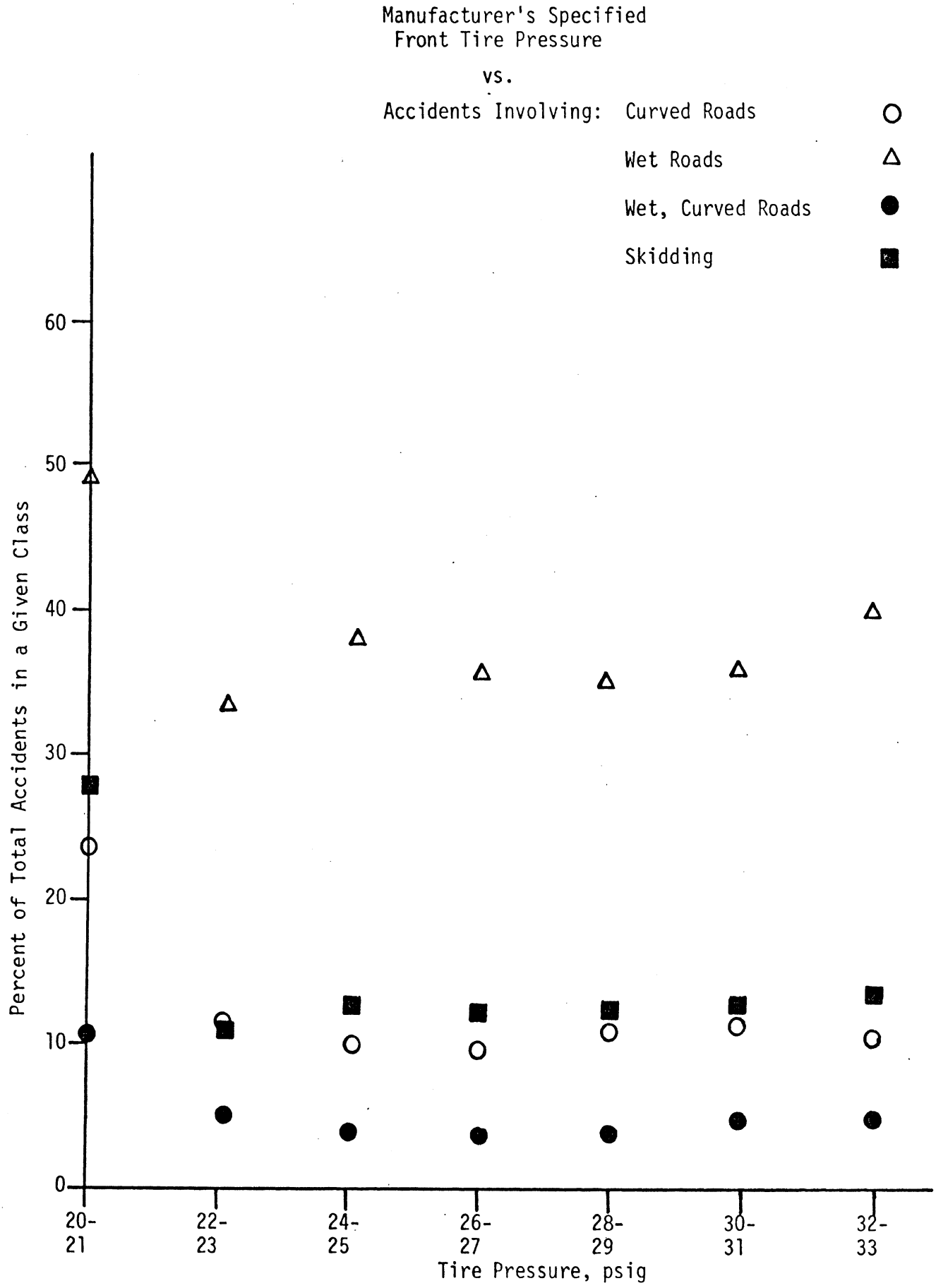

Manufacturer's Specified
Front Tire Pressure
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
20-
21
22-
23
24-
25
26-
27
28-
29
30-
31
32-
33
Tire Pressure, psig

Figure E.3

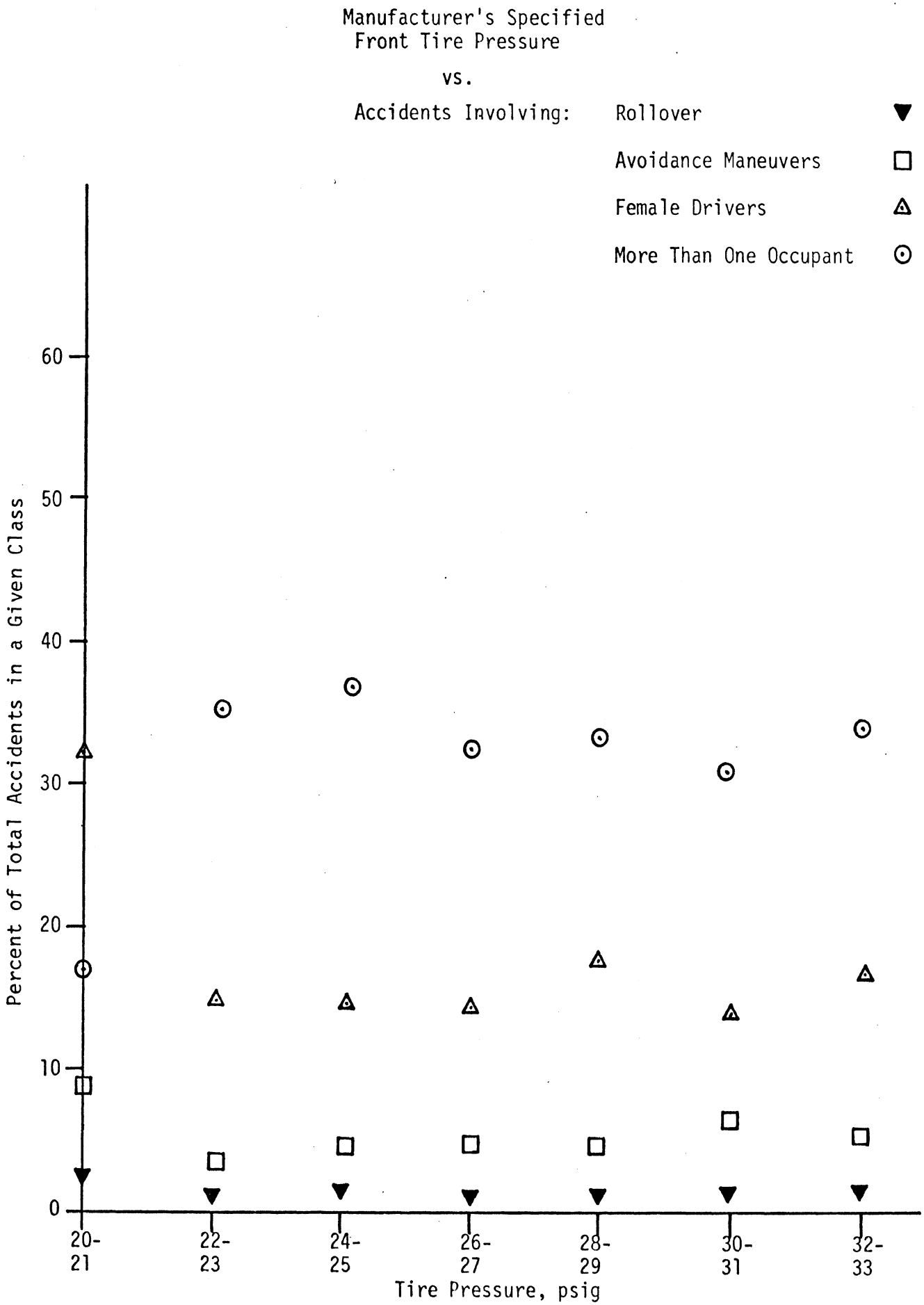

Manufacturer's Specified
Front Tire Pressure
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
20-
21
22-
23
24-
25
26-
27
28-
29
30-
31
32-
33
Tire Pressure, psig

Figure E.4

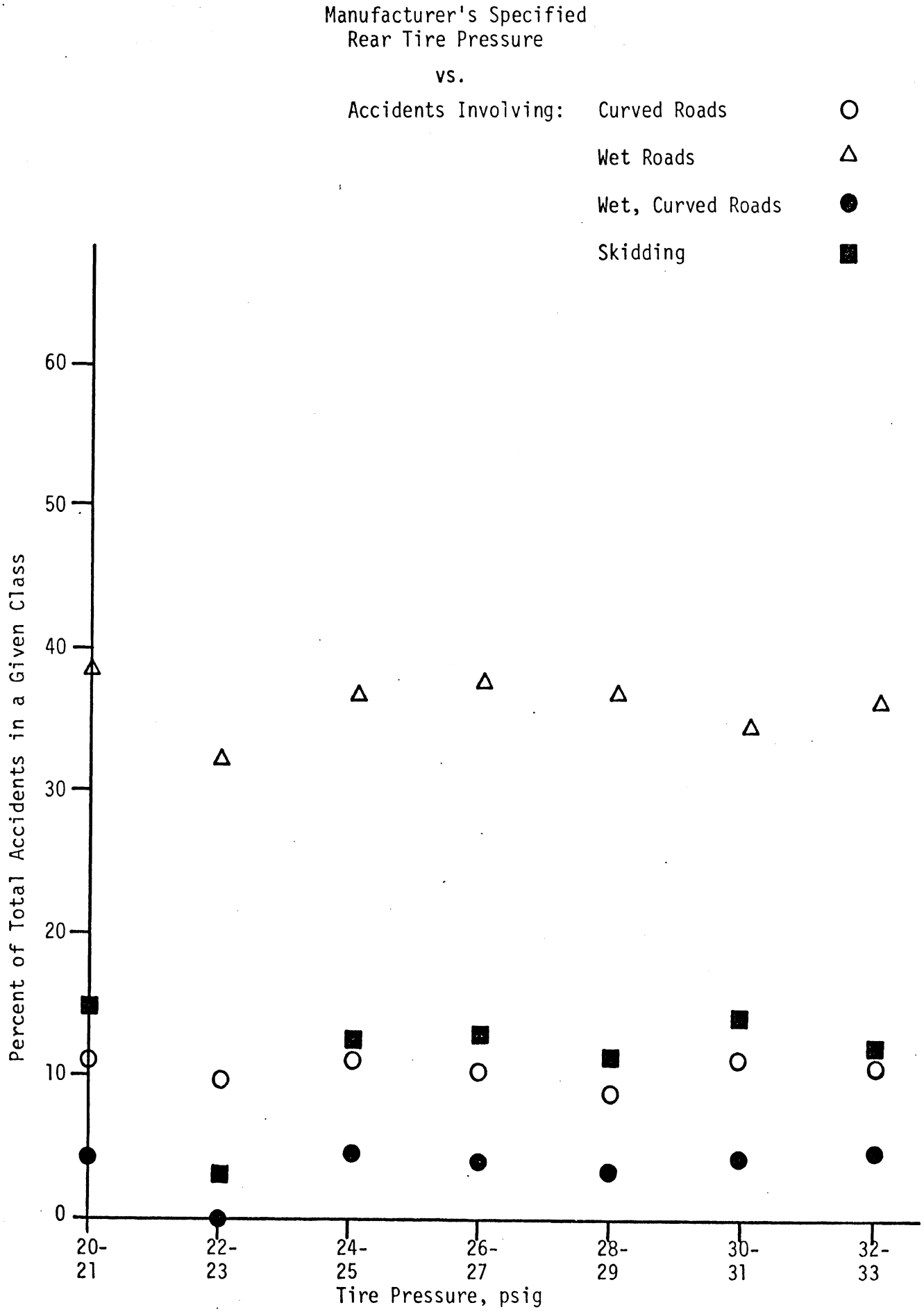

Manufacturer's Specified
Rear Tire Pressure
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
20-
21
22-
23
24-
25
26-
27
28-
29
30-
31
32-
33
Tire Pressure, psig

Figure E.5

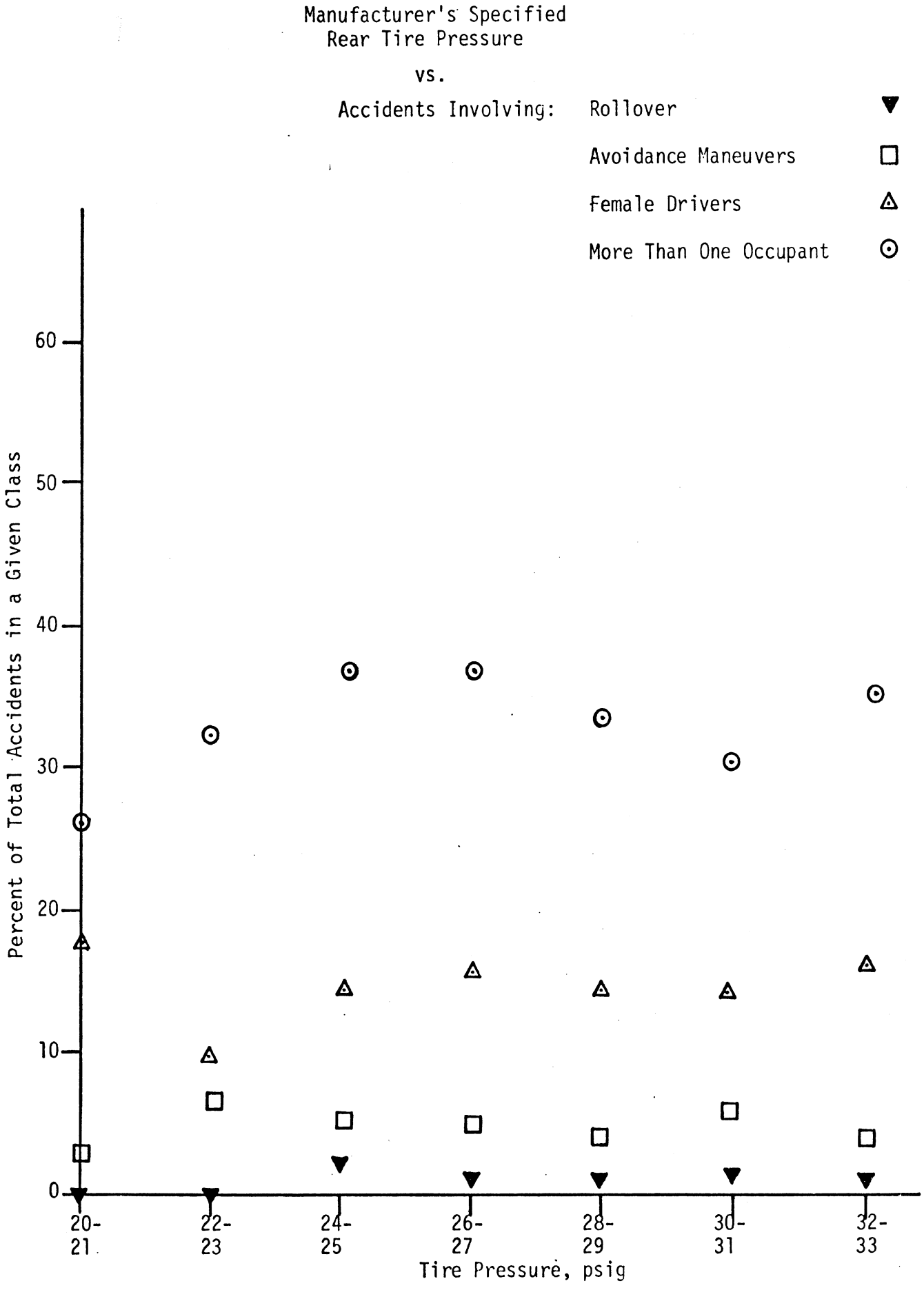

Manufacturer's Specified
Rear Tire Pressure
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
60
50
40
30
20
10
0
20-21
22-23
24-25
26-27
28-29
30-31
32-33
Tire Pressure, psig

Figure E.6

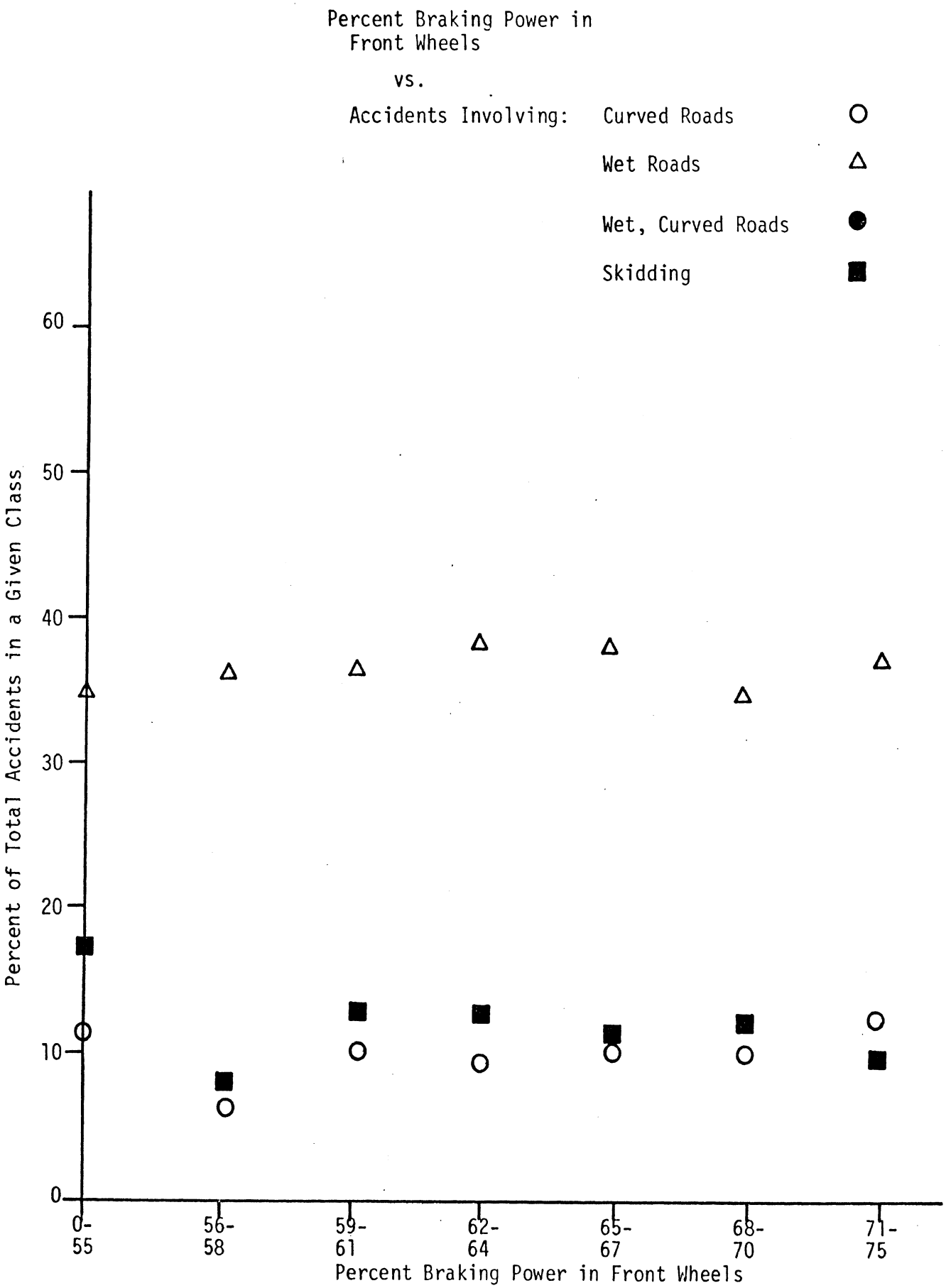

Percent Braking Power in
Front Wheels
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
0-
55
56-
58
59-
61
62-
64
65-
67
68-
70
71-
75
Percent Braking Power in Front Wheels

Figure E.7

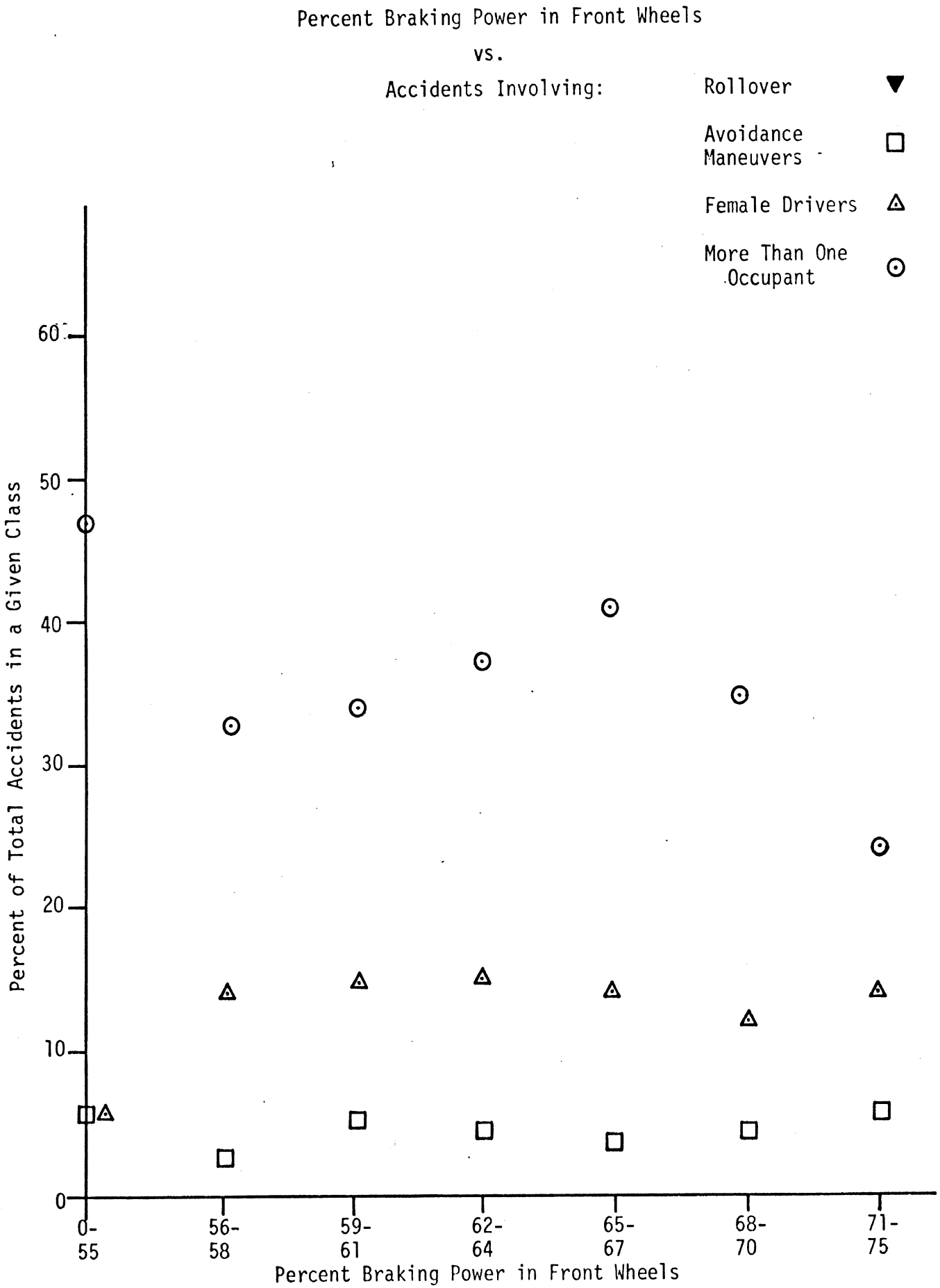

Percent Braking Power in Front Wheels
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
60
50
40
30
20
10
0
0-55
56-58
59-61
62-64
65-67
68-70
71-75
Percent Braking Power in Front Wheels

Figure E.8

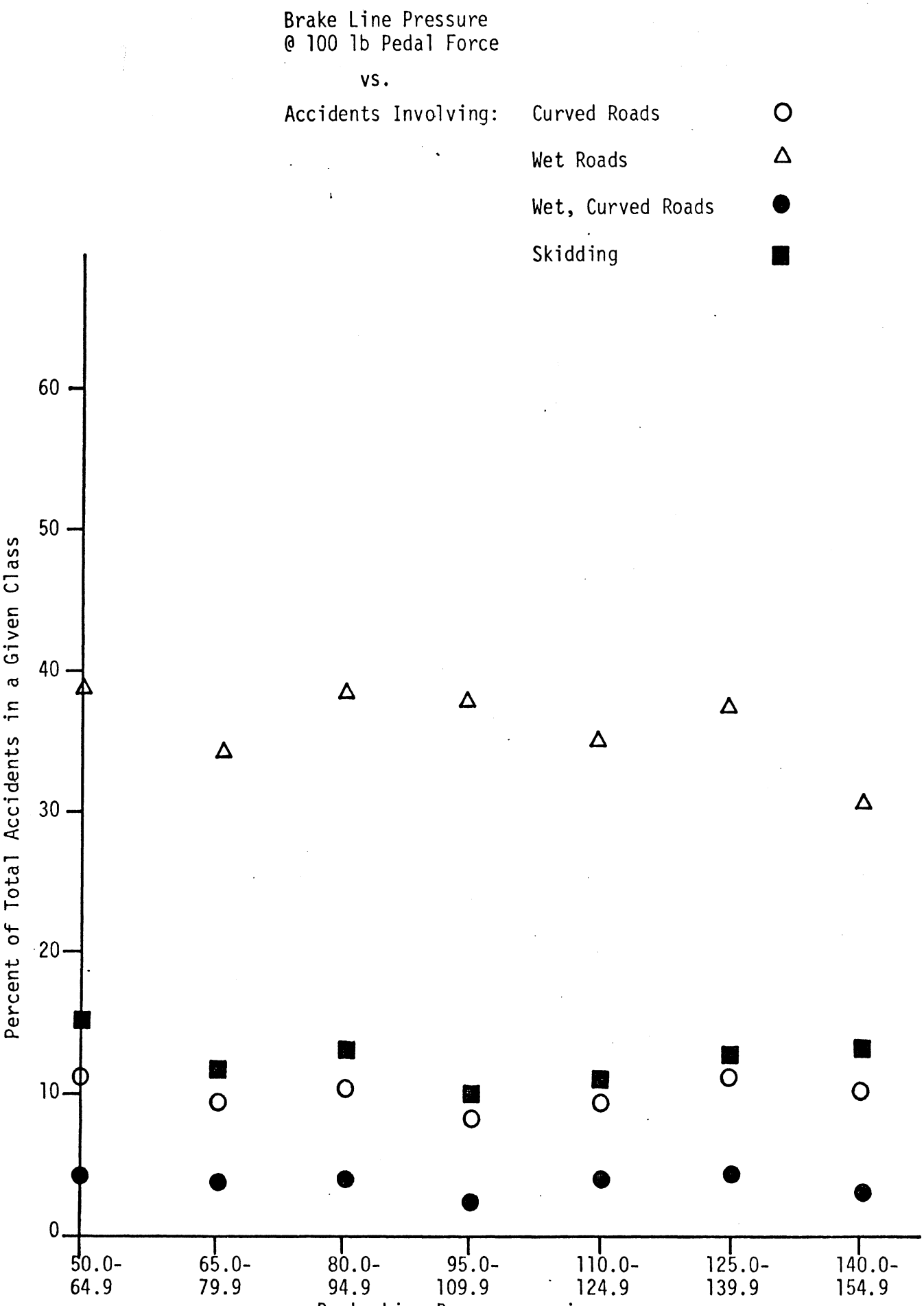

Brake Line Pressure
@ 100 lb Pedal Force
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
50.0-
64.9
65.0-
79.9
80.0-
94.9
95.0-
109.9
110.0-
124.9
125.0-
139.9
140.0-
154.9
Brake Line Pressure, psi

Figure E.9

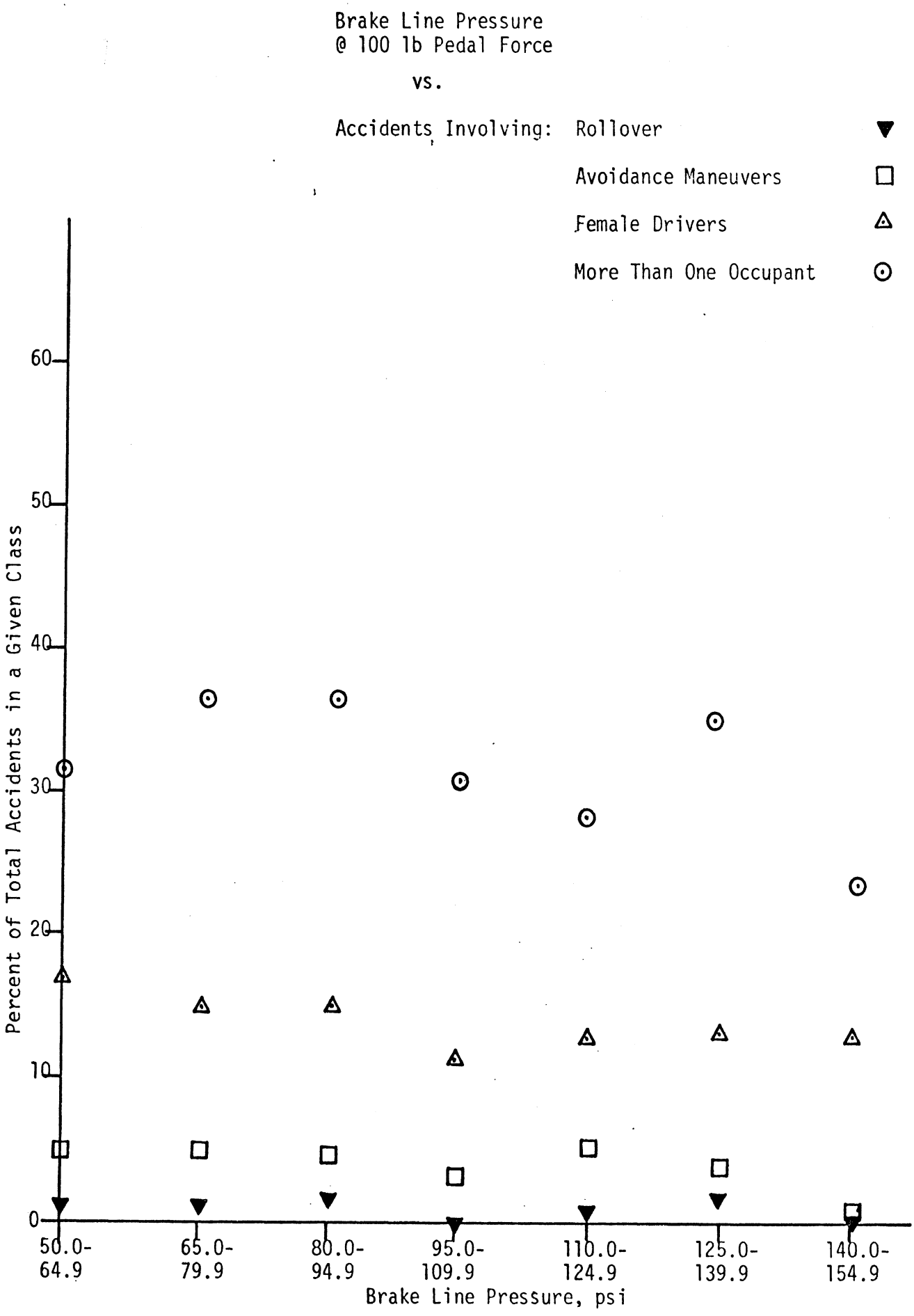

Brake Line Pressure
@ 100 lb Pedal Force
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
60
50
40
30
20
10
0
50.0-
64.9
65.0-
79.9
80.0-
94.9
95.0-
109.9
110.0-
124.9
125.0-
139.9
140.0-
154.9
Brake Line Pressure, psi

Figure E.10

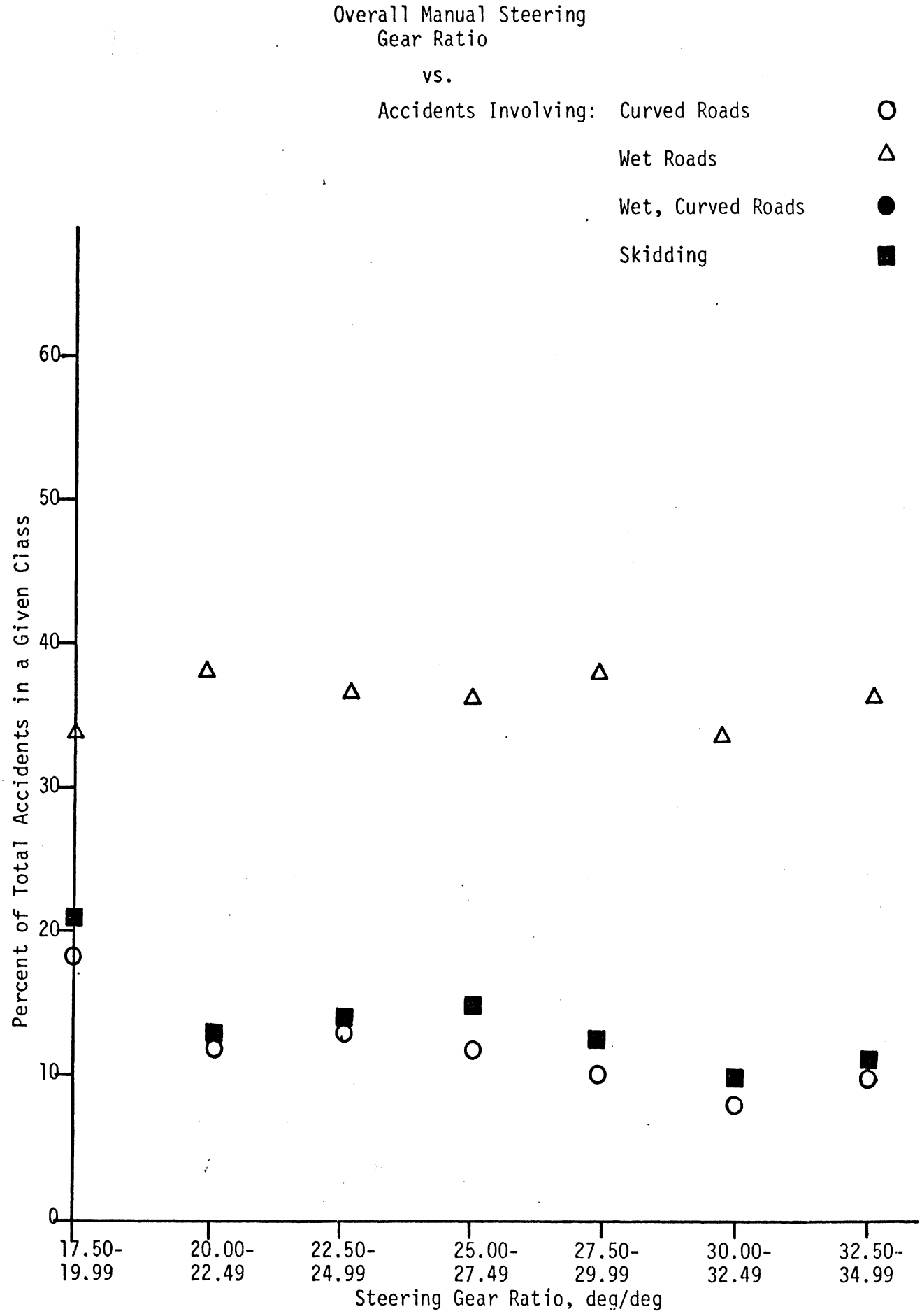

Overall Manual Steering
Gear Ratio
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
60
50
40
30
20
10
0
17.50-
19.99
20.00-
22.49
22.50-
24.99
25.00-
27.49
27.50-
29.99
30.00-
32.49
32.50-
34.99
Steering Gear Ratio, deg/deg

Figure E.11

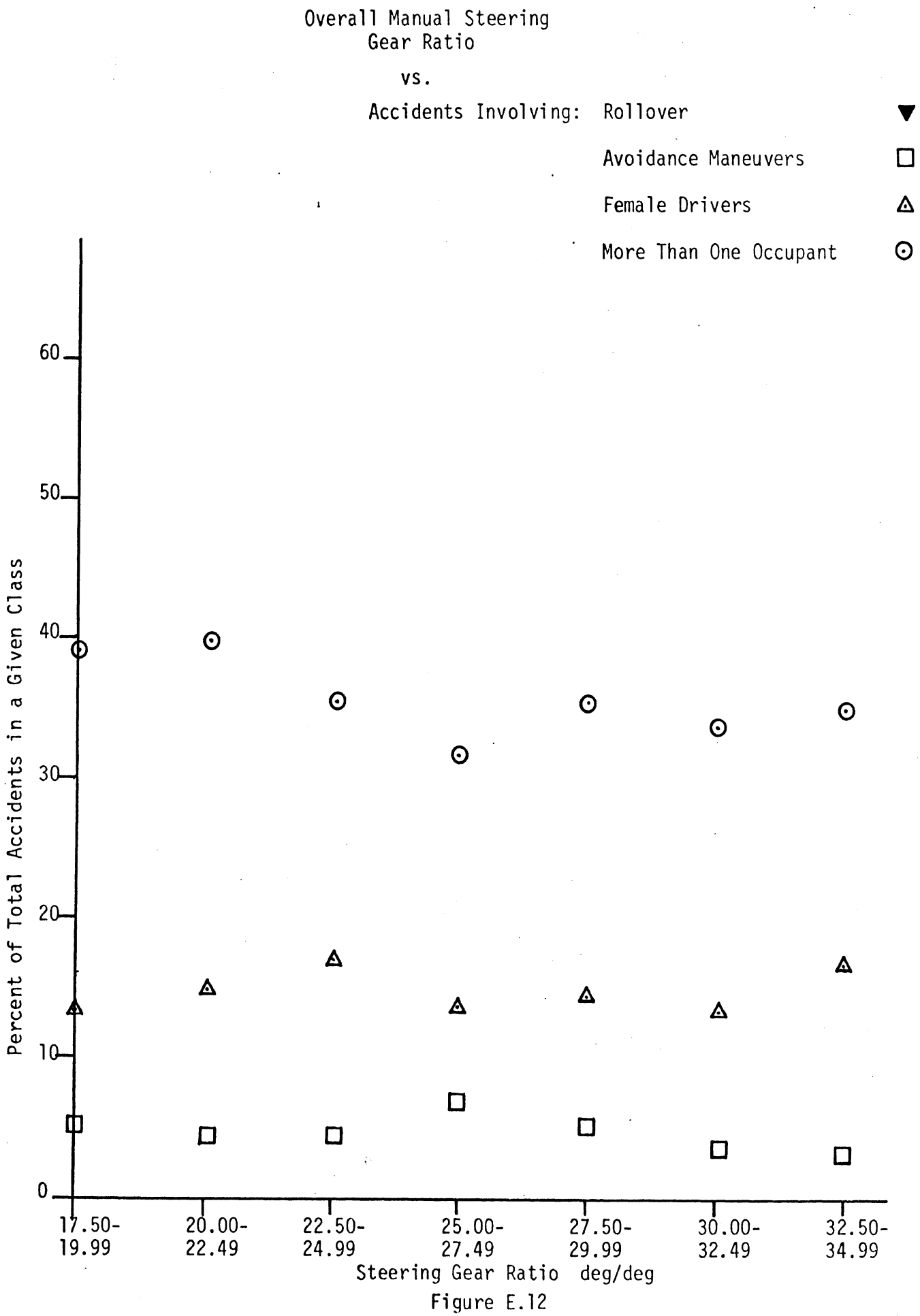

Overall Manual Steering Gear Ratio
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
17.50-19.99
20.00-22.49
22.50-24.99
25.00-27.49
27.50-29.99
30.00-32.49
32.50-34.99
Steering Gear Ratio deg/deg

Figure E.12

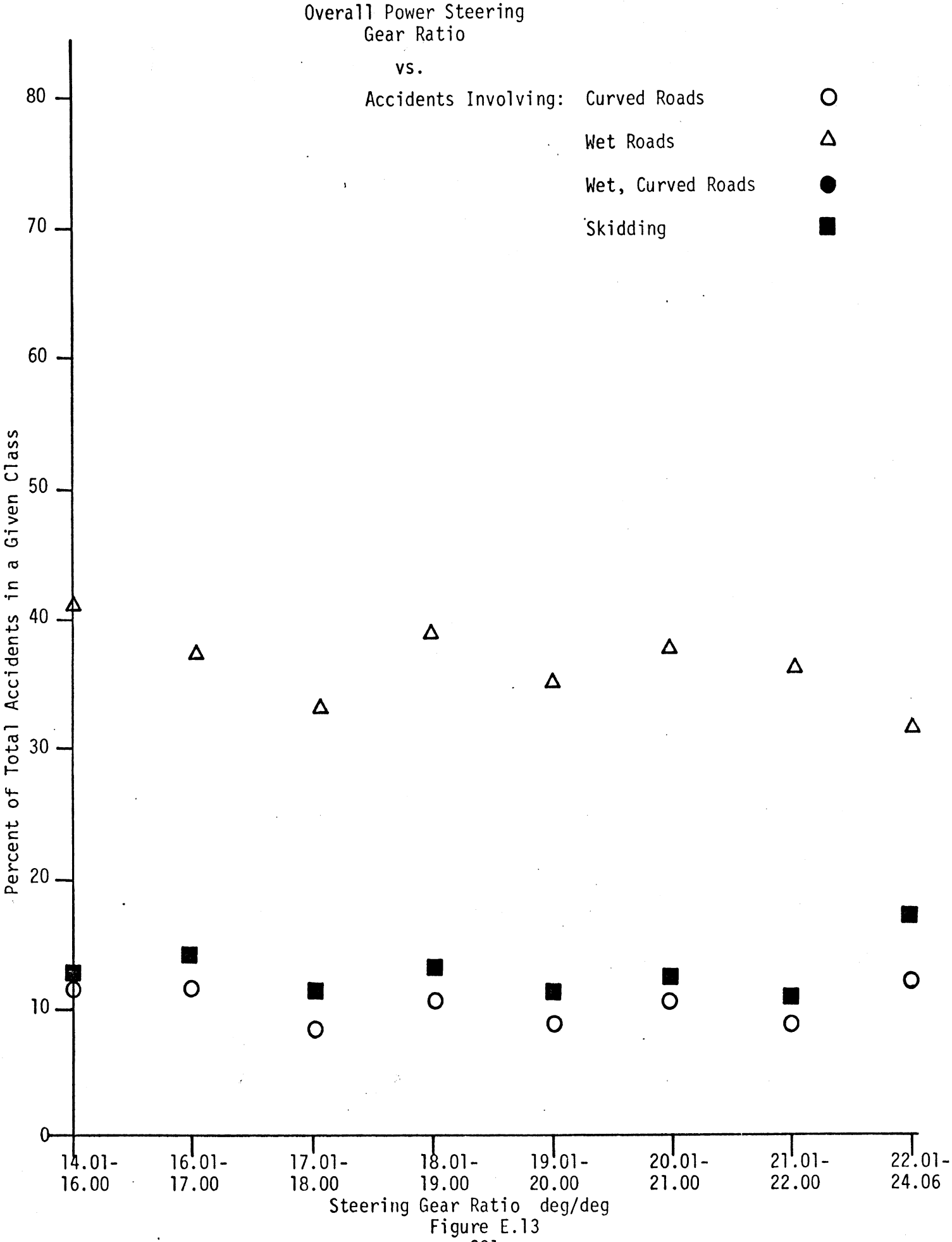

Overall Power Steering
Gear Ratio
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
14.01-
16.00
16.01-
17.00
17.01-
18.00
18.01-
19.00
19.01-
20.00
20.01-
21.00
21.01-
22.00
22.01-
24.06
Steering Gear Ratio deg/deg

Figure E.13

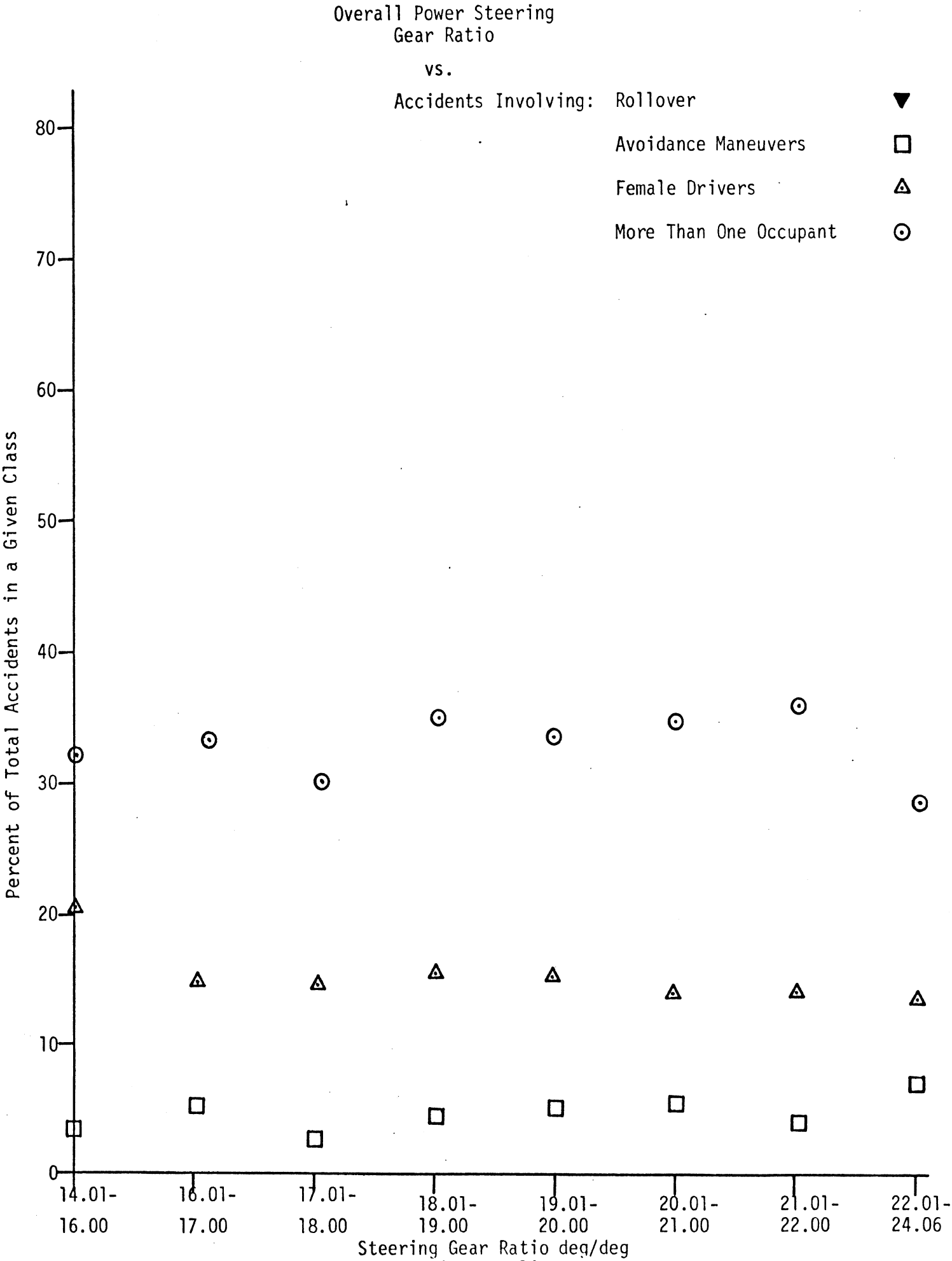

Overall Power Steering
Gear Ratio
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
14.01-16.00
16.01-17.00
17.01-18.00
18.01-19.00
19.01-20.00
20.01-21.00
21.01-22.00
22.01-24.06
Steering Gear Ratio deg/deg

Figure E.14

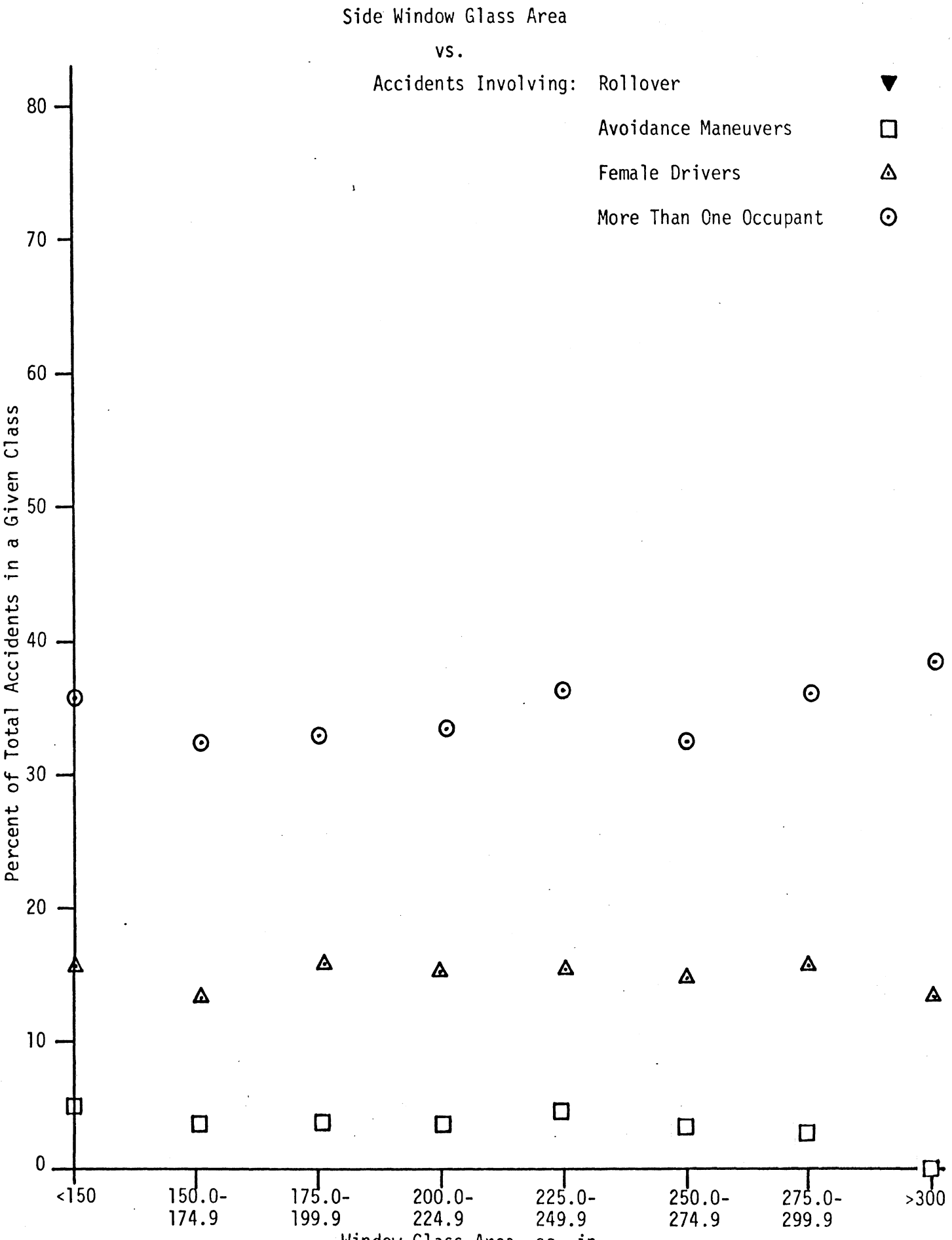

Side Window Glass Area
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
<150
150.0-174.9
175.0-199.9
200.0-224.9
225.0-249.9
250.0-274.9
275.0-299.9
>300
Window Glass Area, sq. in.

Figure E.16

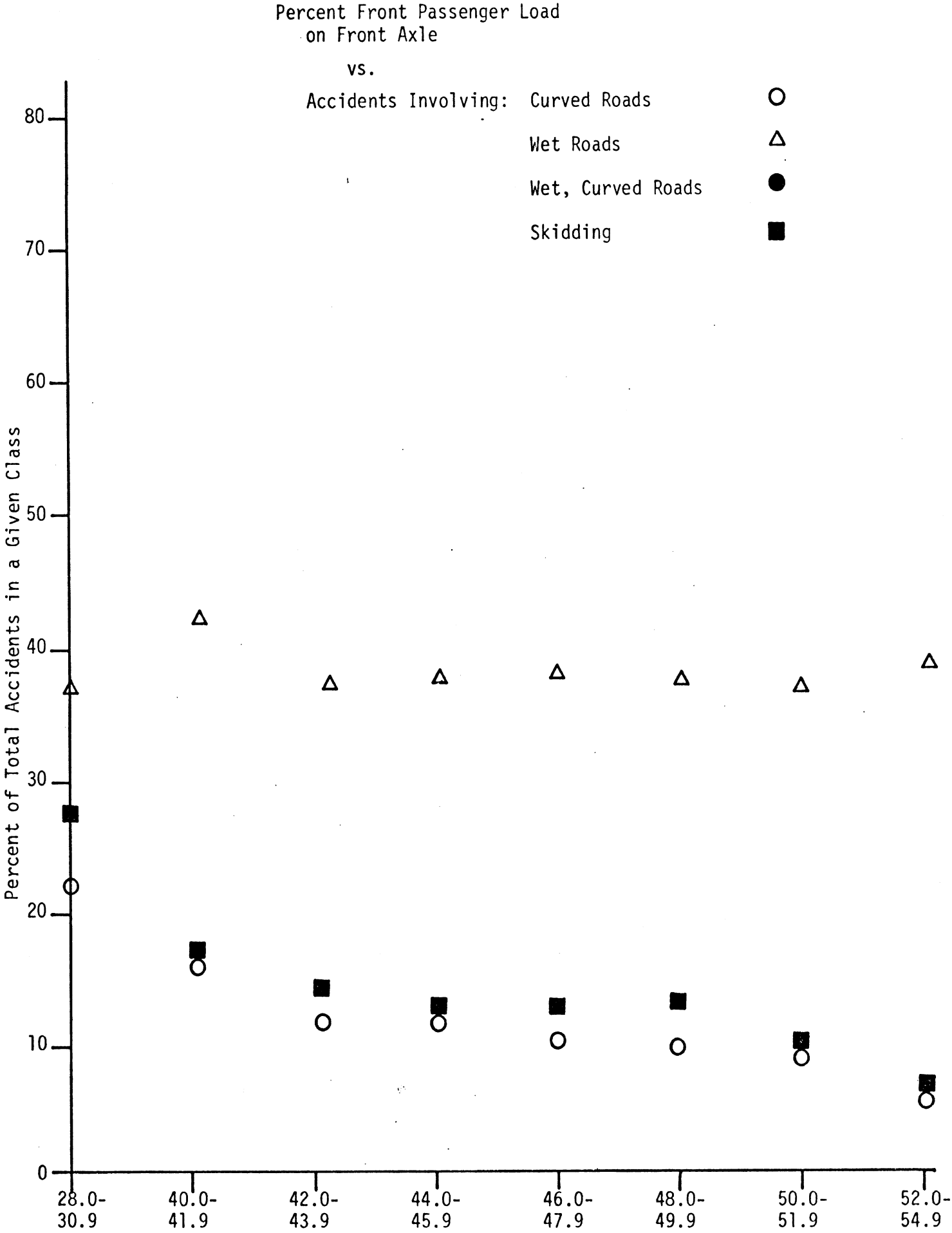

Percent Front Passenger Load
on Front Axle
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
28.0-
30.9
40.0-
41.9
42.0-
43.9
44.0-
45.9
46.0-
47.9
48.0-
49.9
50.0-
51.9
52.0-
54.9
Percent Load on Front Axle

Figure E.17

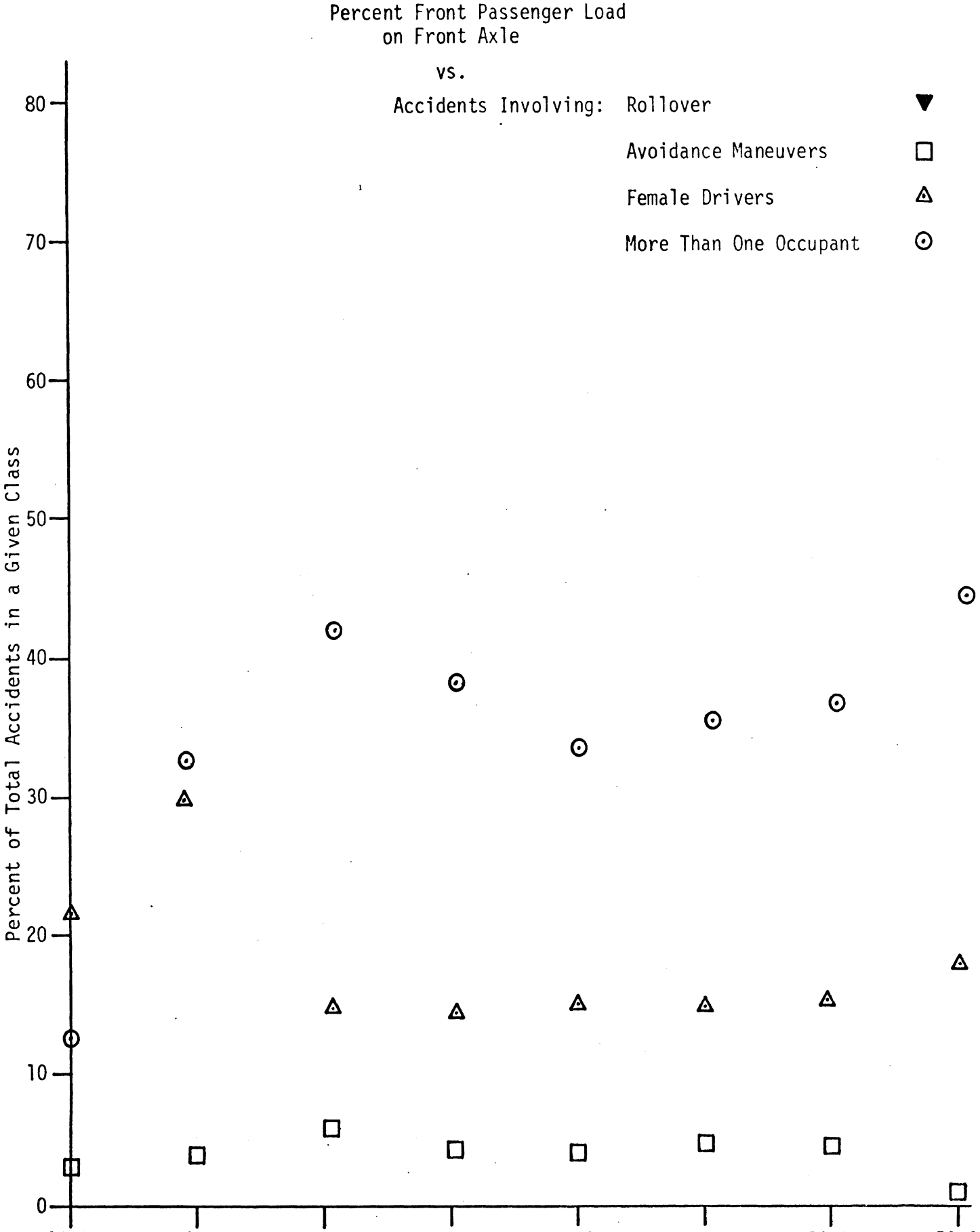

Percent Front Passenger Load
on Front Axle
vs.
Accidents Involving: Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
28.0-
30.9
40.0-
41.9
42.0-
43.9
44.0-
45.9
46.0-
47.9
48.0-
49.9
50.0-
51.9
52.0-
54.9
Percent Load on Front Axle

Figure E.18

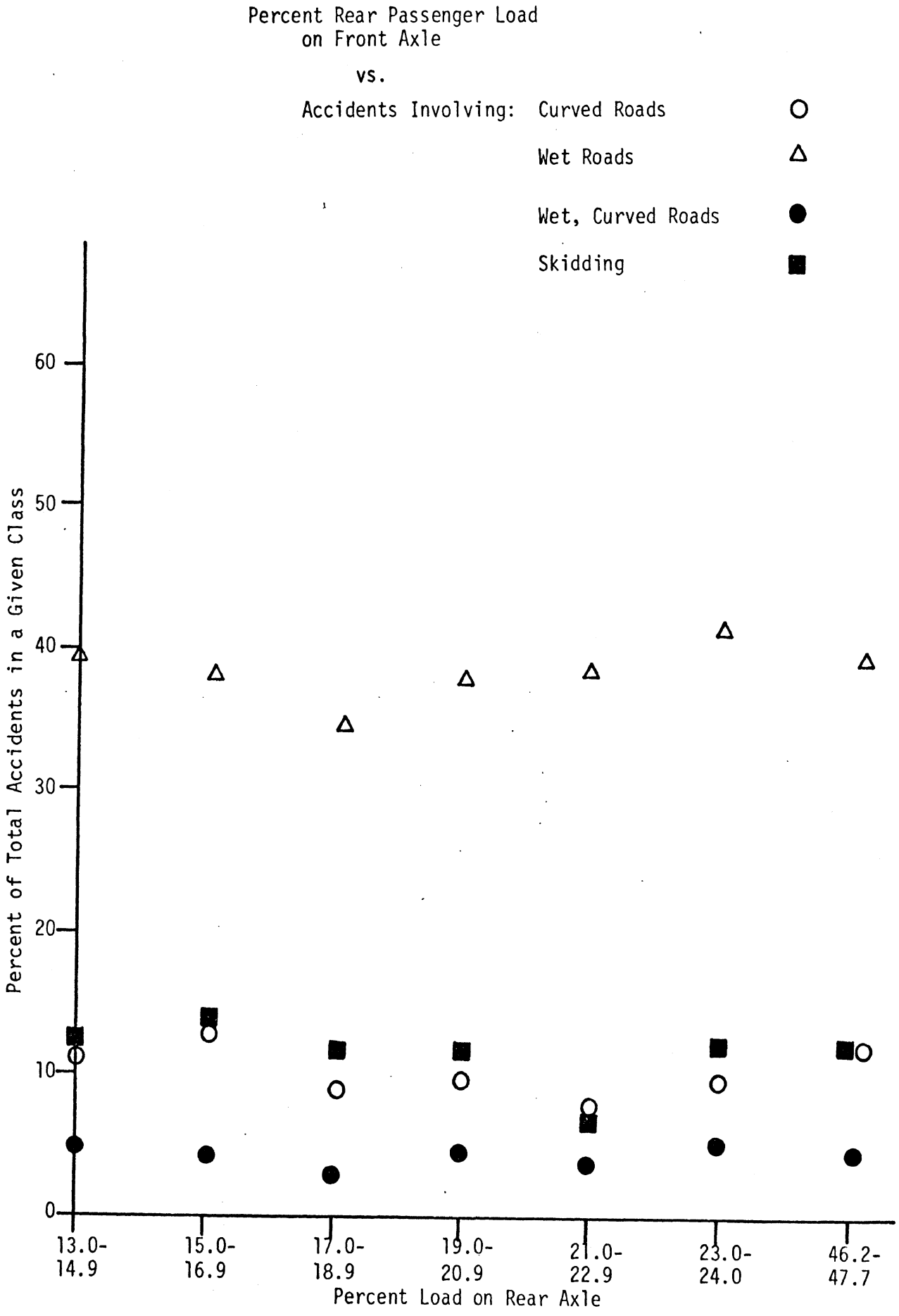

Percent Rear Passenger Load
on Front Axle
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
13.0-
14.9
15.0-
16.9
17.0-
18.9
19.0-
20.9
21.0-
22.9
23.0-
24.0
46.2-
47.7
Percent Load on Rear Axle

Figure E.19

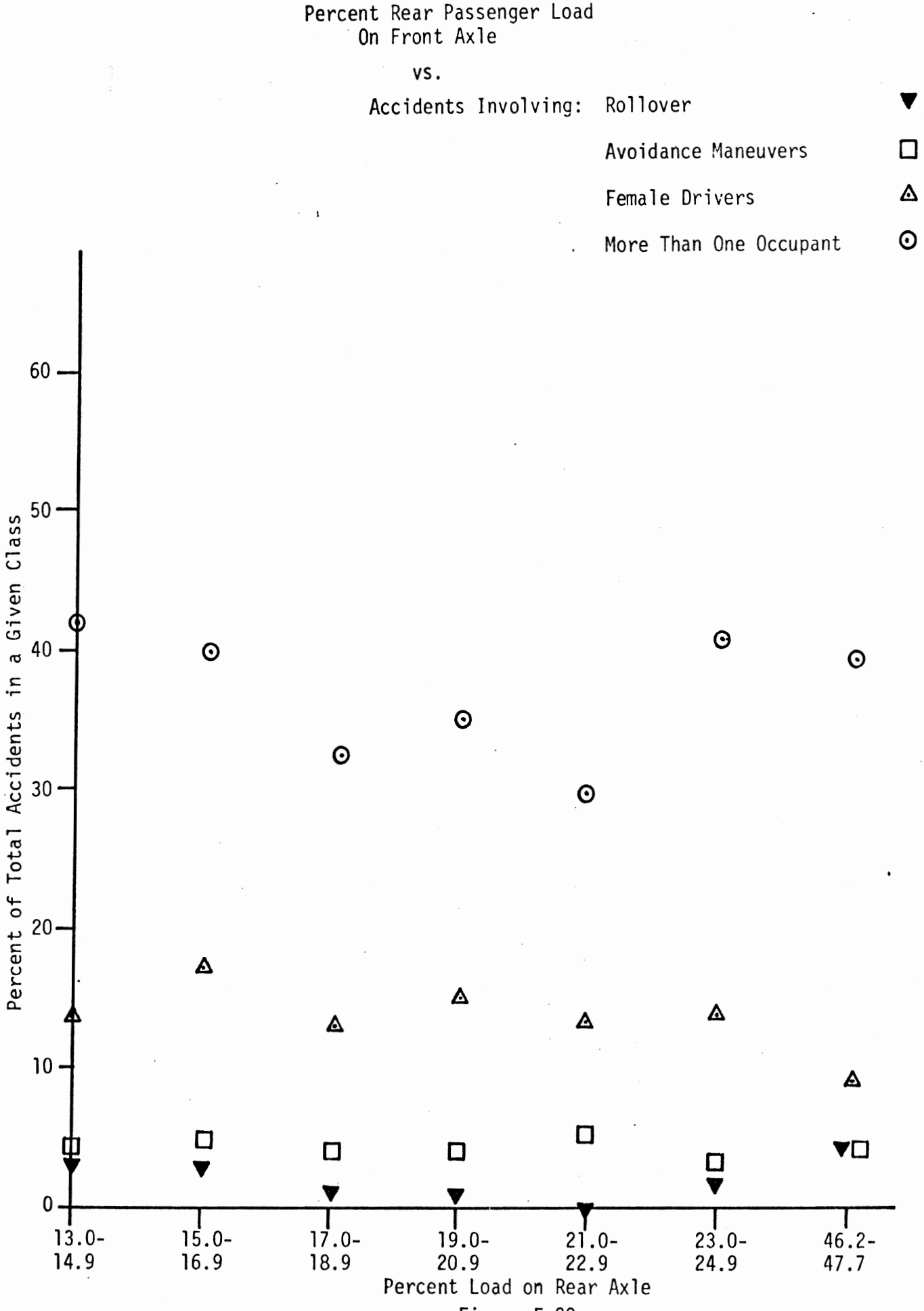

Percent Rear Passenger Load
On Front Axle
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
60
50
40
30
20
10
0
13.0-
14.9
15.0-
16.9
17.0-
18.9
19.0-
20.9
21.0-
22.9
23.0-
24.9
46.2-
47.7
Percent Load on Rear Axle

Figure E.20

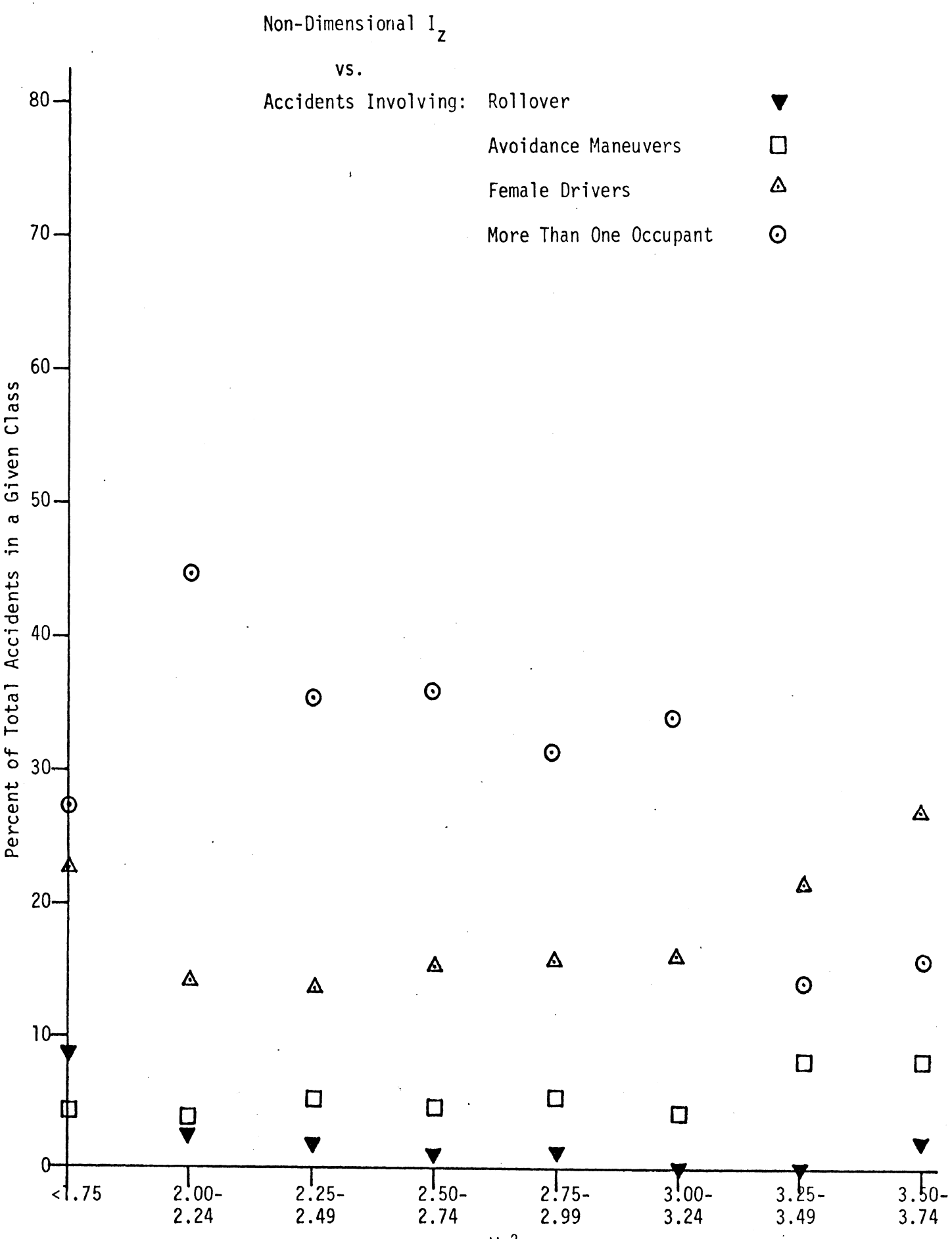

Non-Dimensional I_z
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
80
70
60
50
40
30
20
10
0
<1.75
2.00-2.24
2.25-2.49
2.50-2.74
2.75-2.99
3.00-3.24
3.25-3.49
3.50-3.74
$I_z \div (\frac{W\ell^2}{32.2})$

Figure E.21

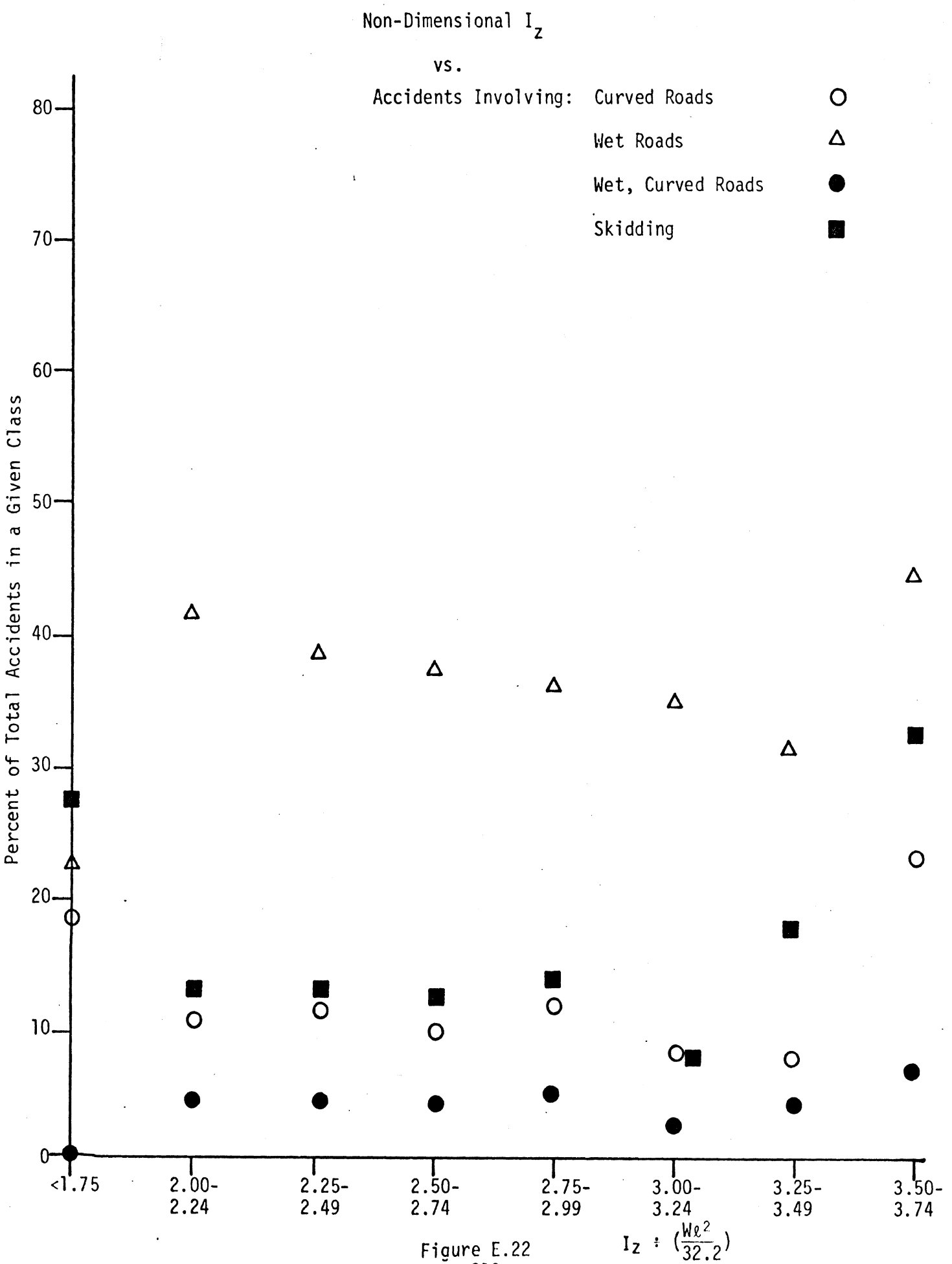

Non-Dimensional I_z
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
<1.75
2.00-2.24
2.25-2.49
2.50-2.74
2.75-2.99
3.00-3.24
3.25-3.49
3.50-3.74
$Iz = (\frac{W\ell^2}{32.2})$

Figure E.22

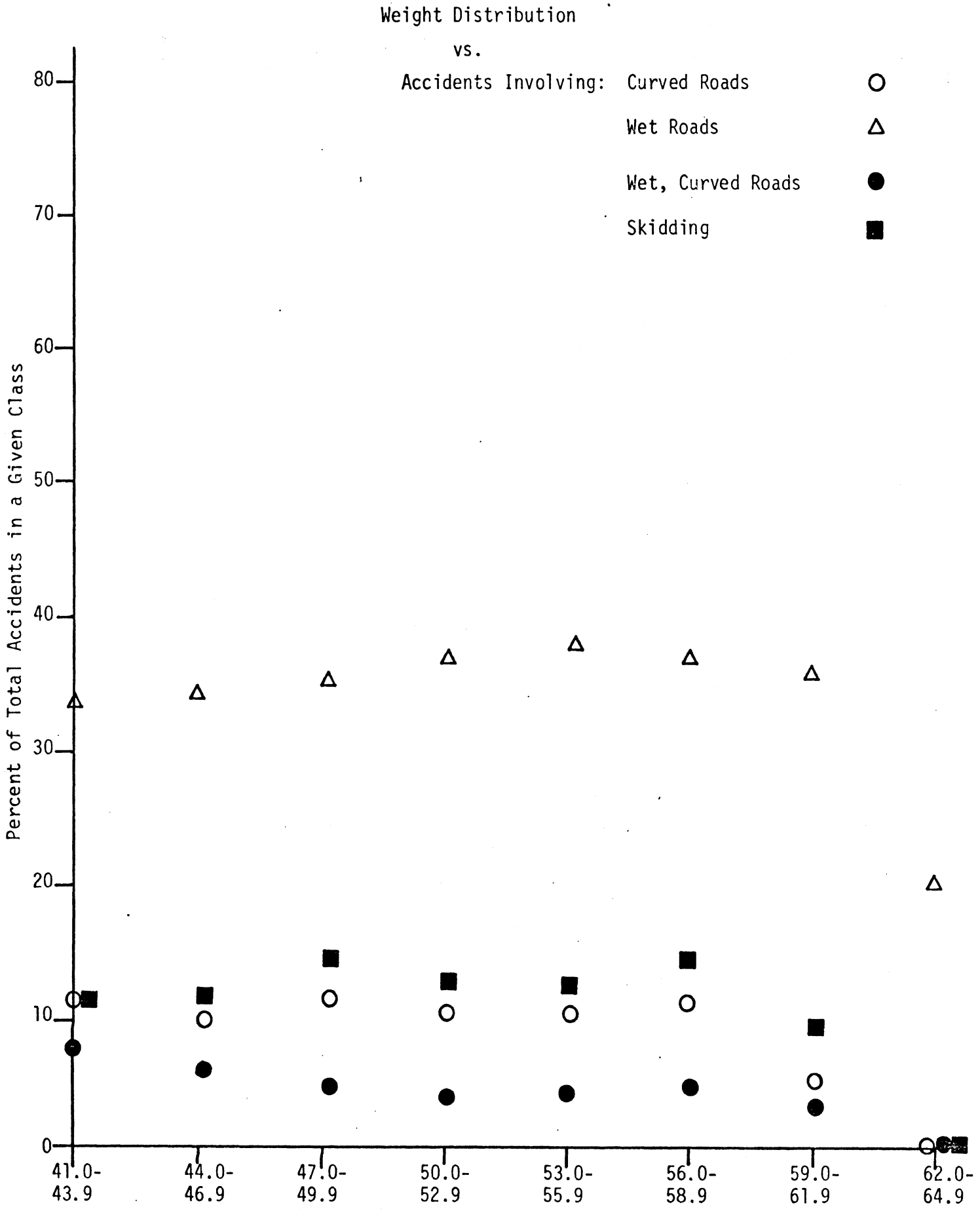

Weight Distribution
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
41.0-43.9
44.0-46.9
47.0-49.9
50.0-52.9
53.0-55.9
56.0-58.9
59.0-61.9
62.0-64.9
Front Axle Weight : Total Weight

Figure E.23

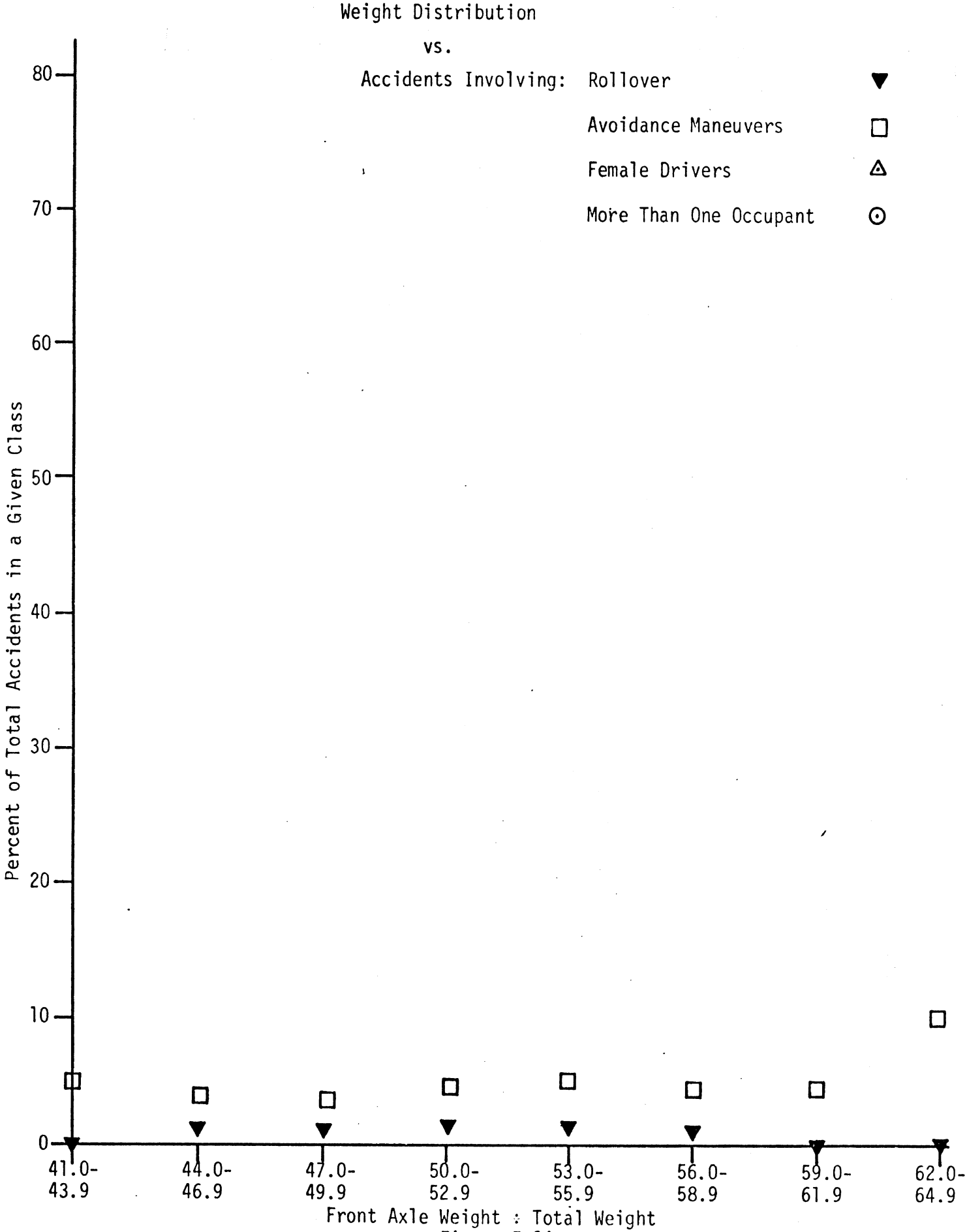

Weight Distribution
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
80
70
60
50
40
30
20
10
0
41.0-43.9
44.0-46.9
47.0-49.9
50.0-52.9
53.0-55.9
56.0-58.9
59.0-61.9
62.0-64.9
Front Axle Weight : Total Weight

Figure E.24

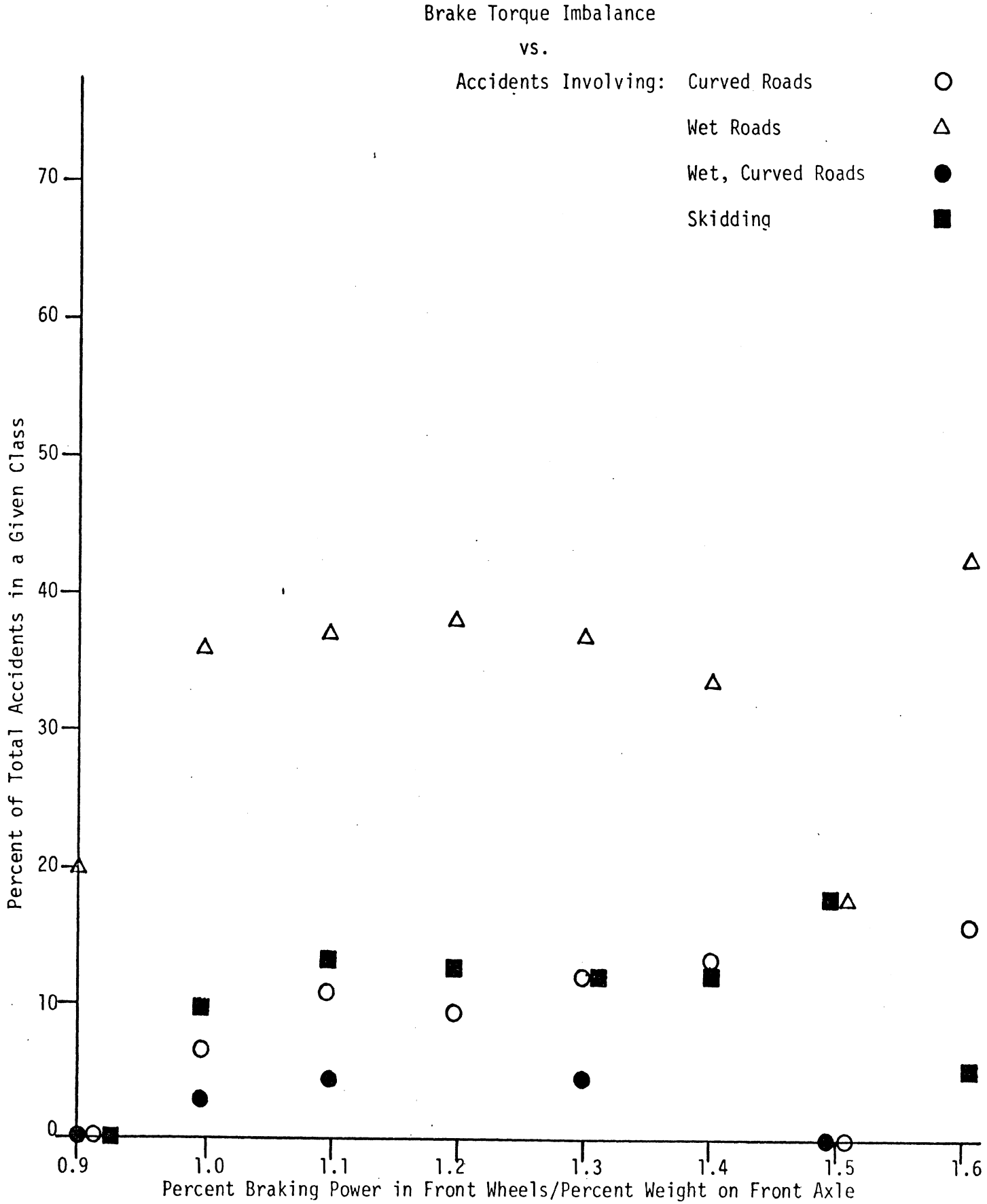

Brake Torque Imbalance
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Percent Braking Power in Front Wheels/Percent Weight on Front Axle

Figure E.25

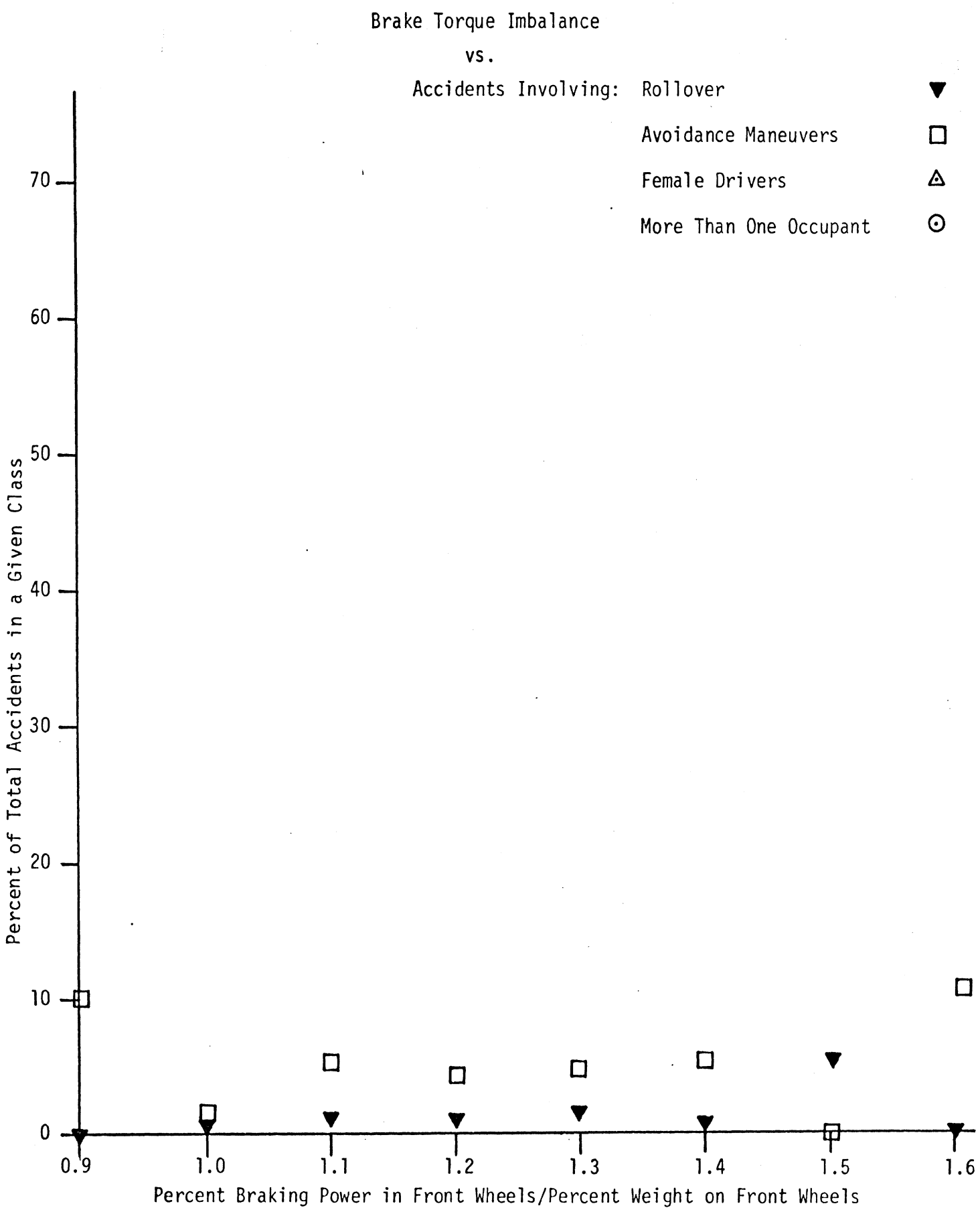

Brake Torque Imbalance
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
70
60
50
40
30
20
10
0
0.9
1.0
1.1
1.2
1.3
1.4
1.5
1.6
Percent Braking Power in Front Wheels/Percent Weight on Front Wheels

Figure E.26

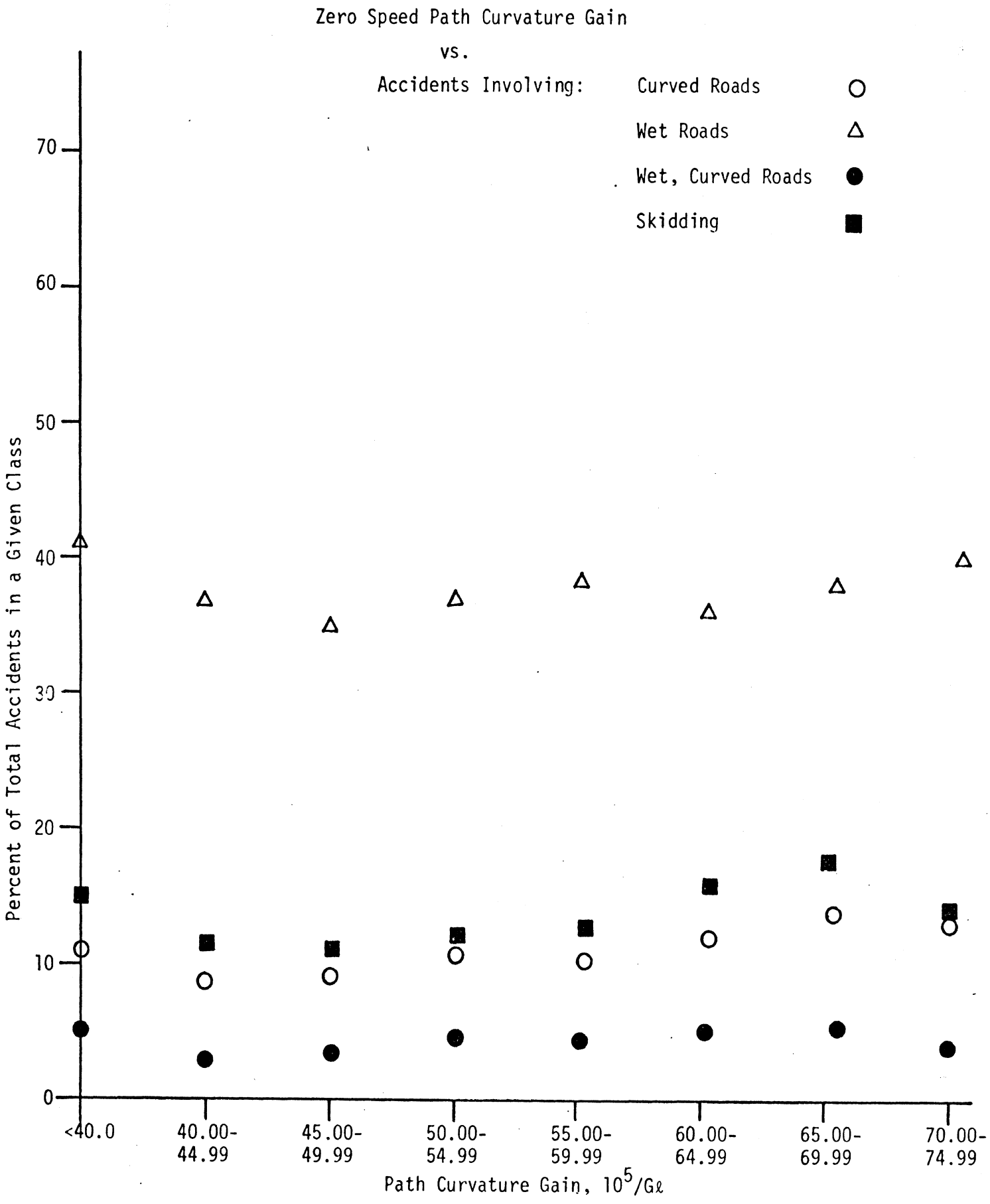

Zero Speed Path Curvature Gain
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
<40.0
40.00-44.99
45.00-49.99
50.00-54.99
55.00-59.99
60.00-64.99
65.00-69.99
70.00-74.99
Path Curvature Gain, $10^5/G\ell$

Figure E.27

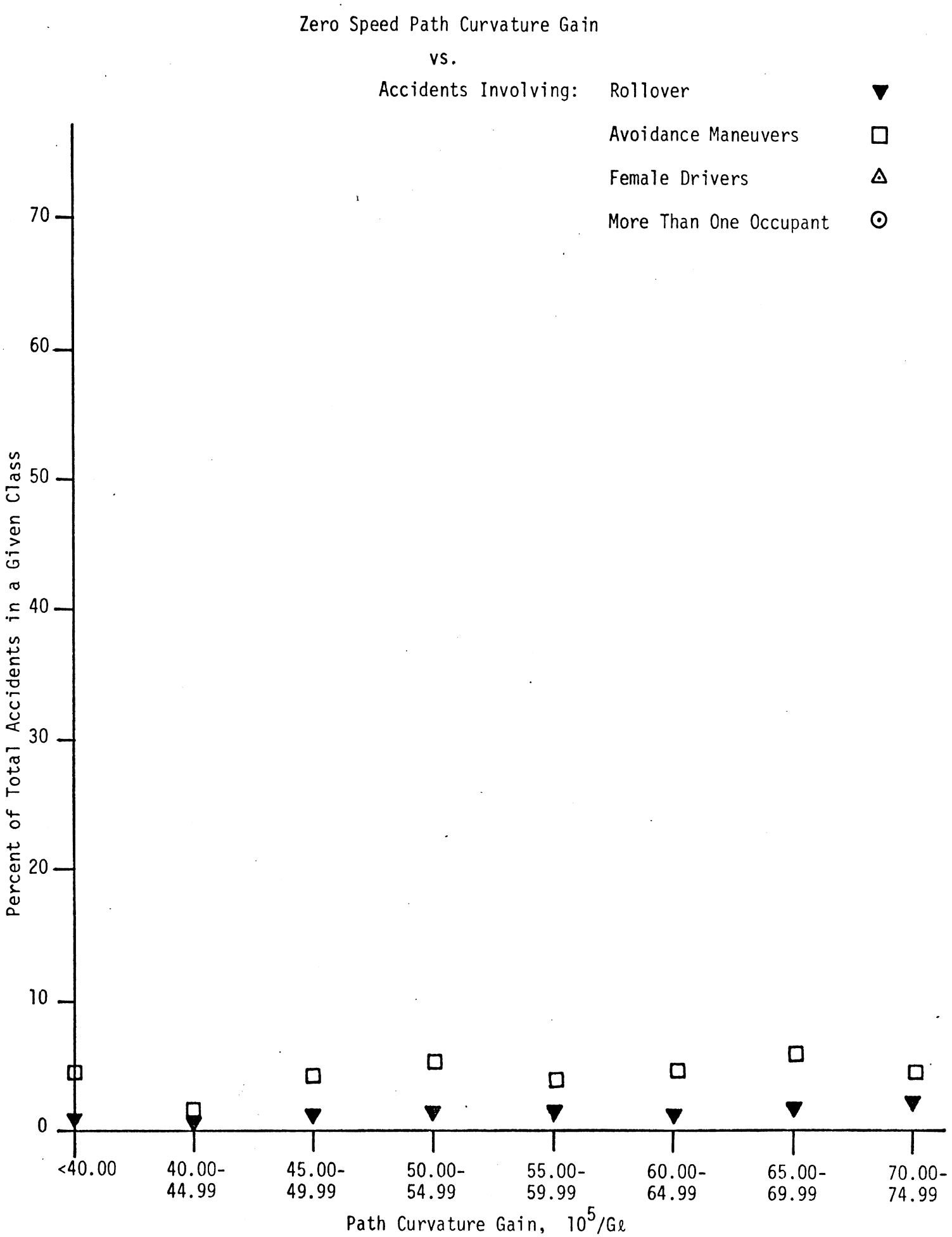

Zero Speed Path Curvature Gain
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
70
60
50
40
30
20
10
0
<40.00
40.00-44.99
45.00-49.99
50.00-54.99
55.00-59.99
60.00-64.99
65.00-69.99
70.00-74.99
Path Curvature Gain, $10^5/G\ell$

Figure E.28

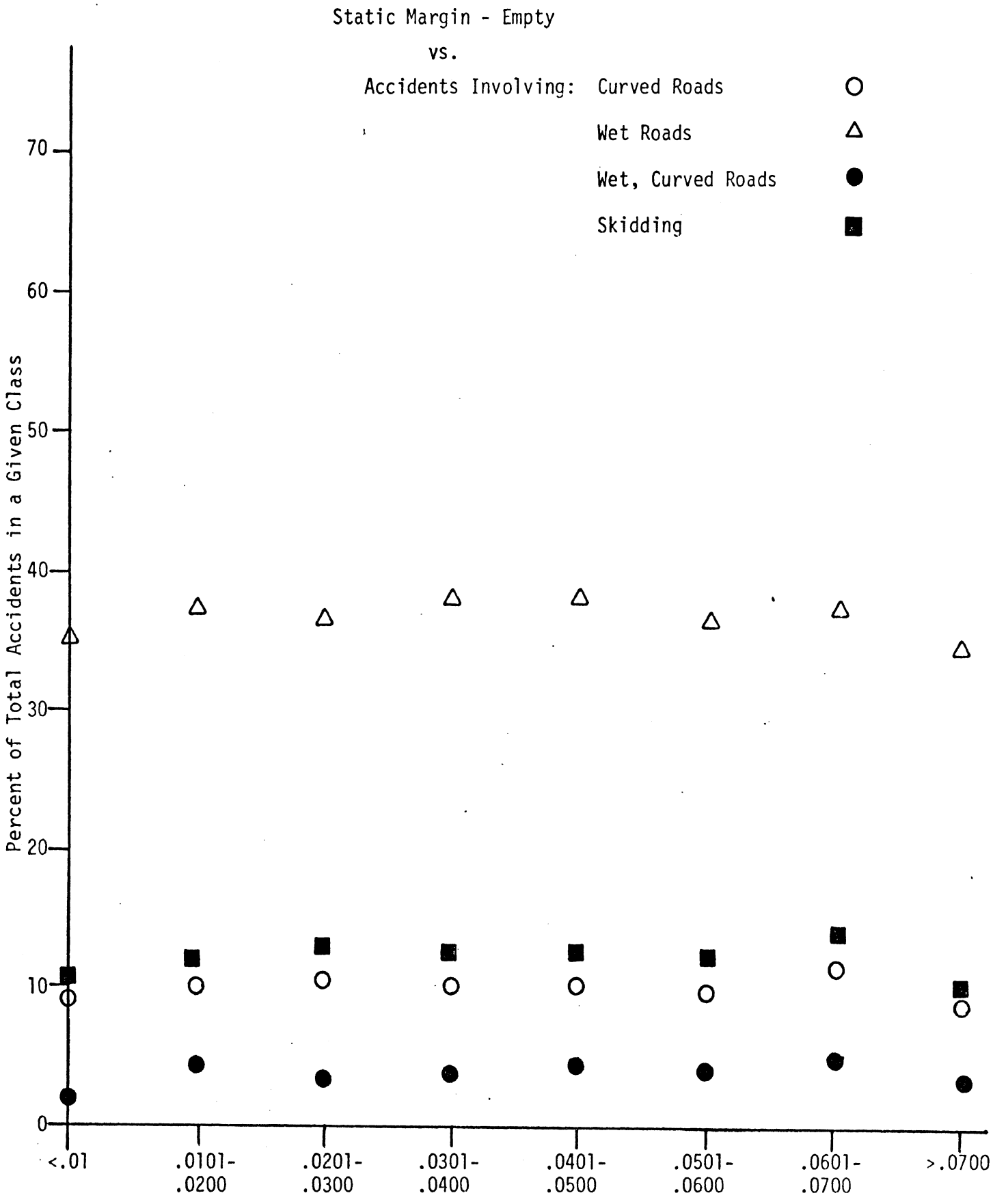

Static Margin - Empty
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
<.01
.0101-.0200
.0201-.0300
.0301-.0400
.0401-.0500
.0501-.0600
.0601-.0700
>.0700
Static Margin, a-b/2ℓ

Figure E.29

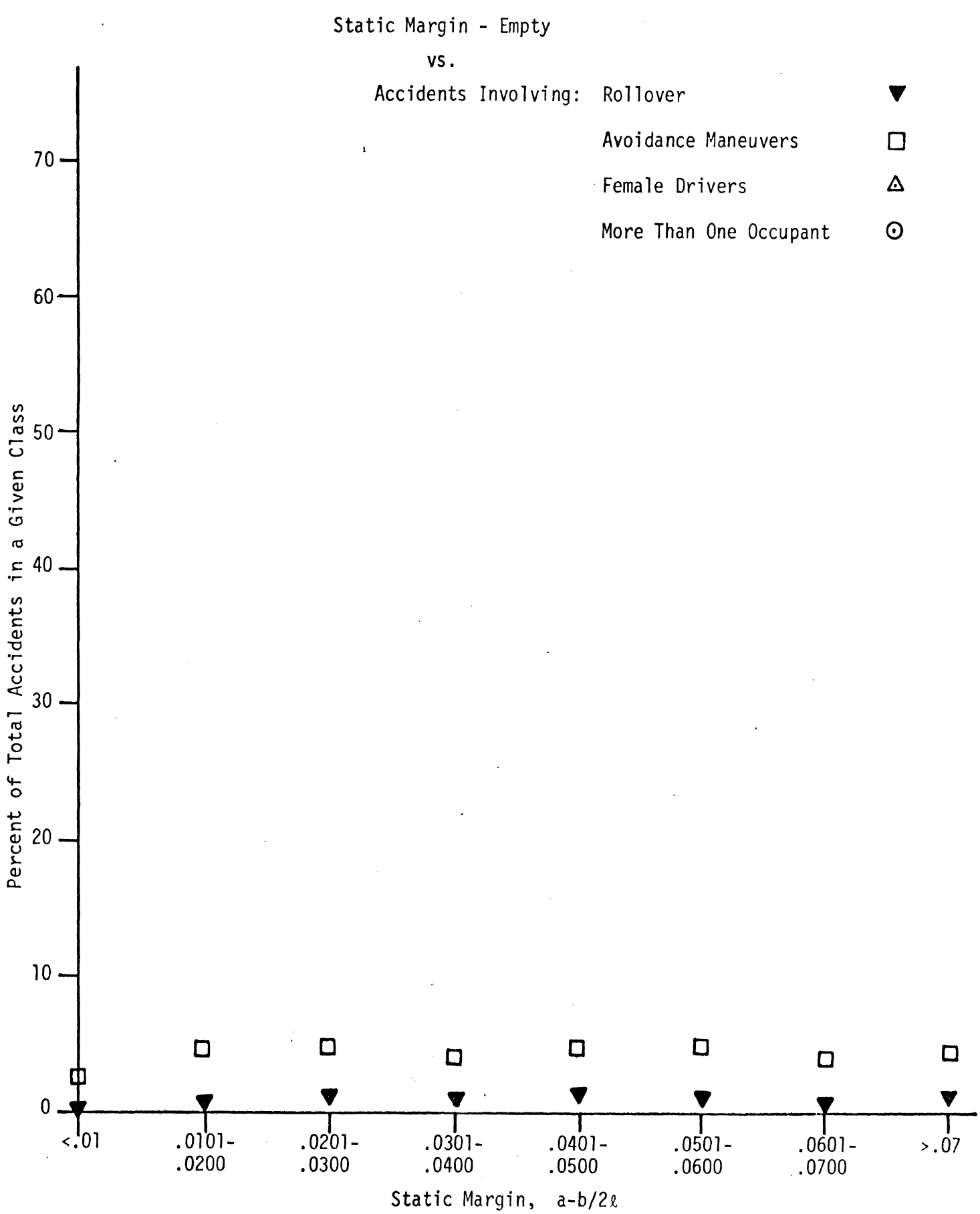

Static Margin - Empty
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
70
60
50
40
30
20
10
0
<.01
.0101-.0200
.0201-.0300
.0301-.0400
.0401-.0500
.0501-.0600
.0601-.0700
>.07
Static Margin, a-b/2ℓ

Figure E.30

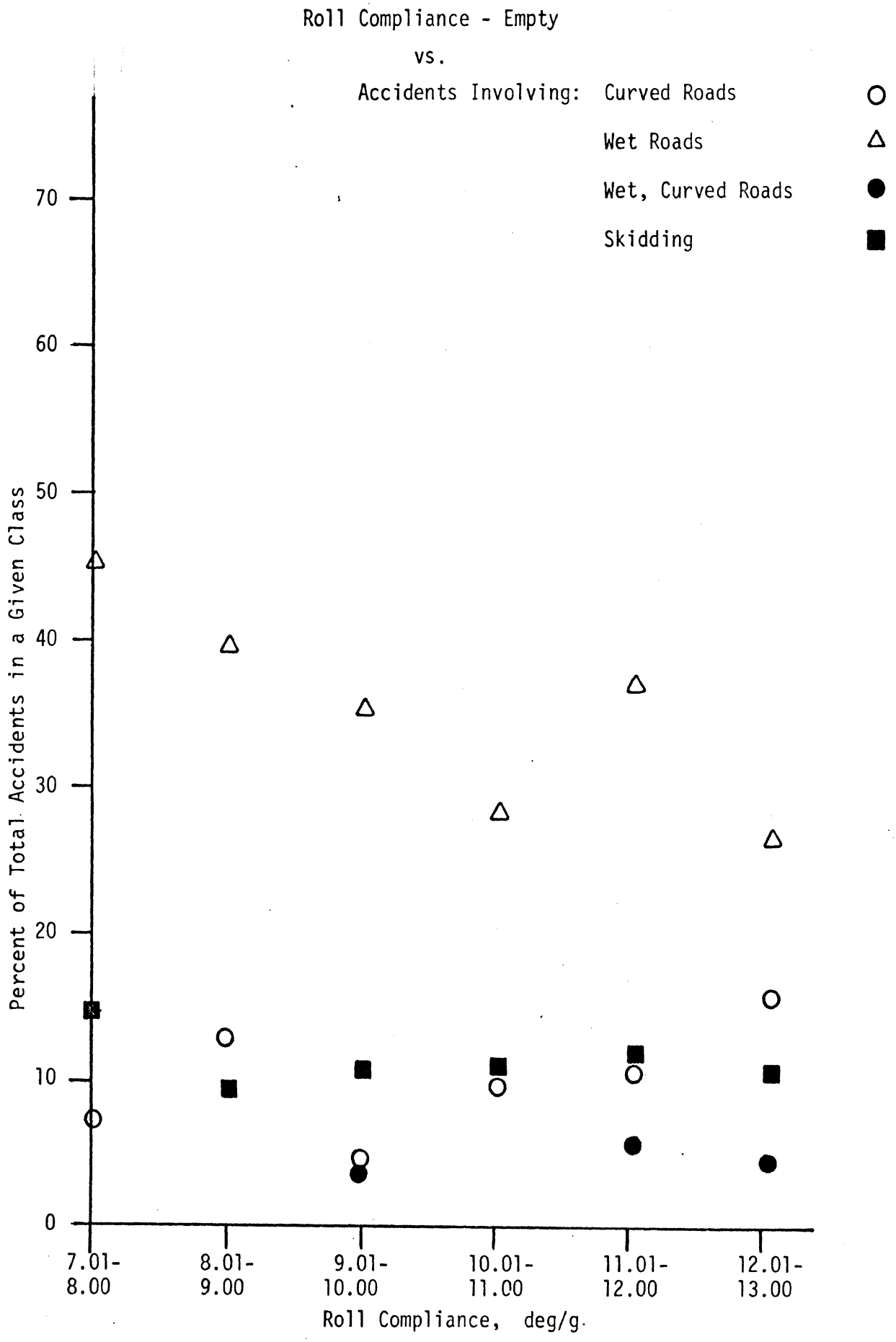

Roll Compliance - Empty
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
7.01-8.00
8.01-9.00
9.01-10.00
10.01-11.00
11.01-12.00
12.01-13.00
Roll Compliance, deg/g

Figure E.31

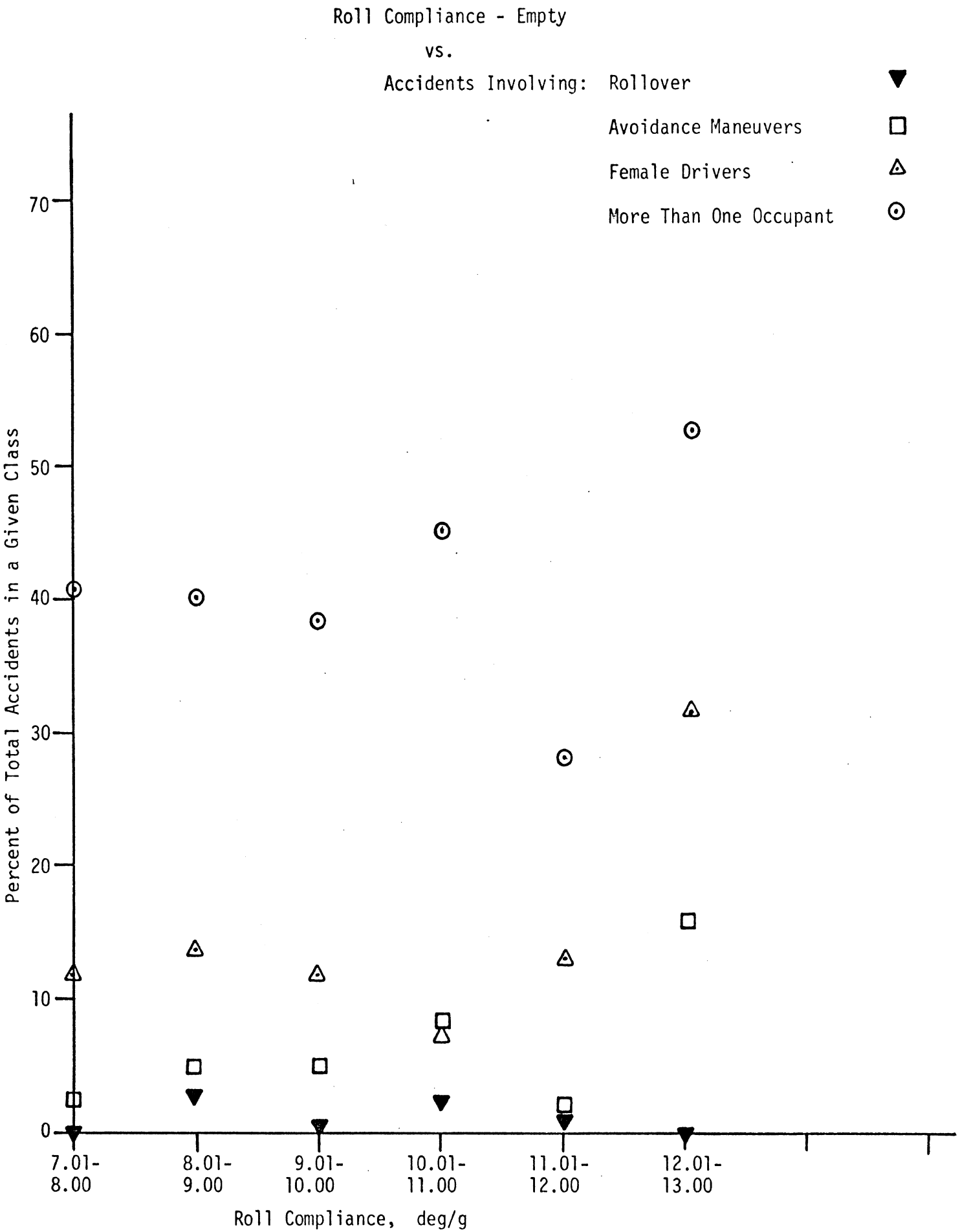

Roll Compliance - Empty
vs.
Accidents Involving: Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
7.01-8.00
8.01-9.00
9.01-10.00
10.01-11.00
11.01-12.00
12.01-13.00
Roll Compliance, deg/g

Figure E.32

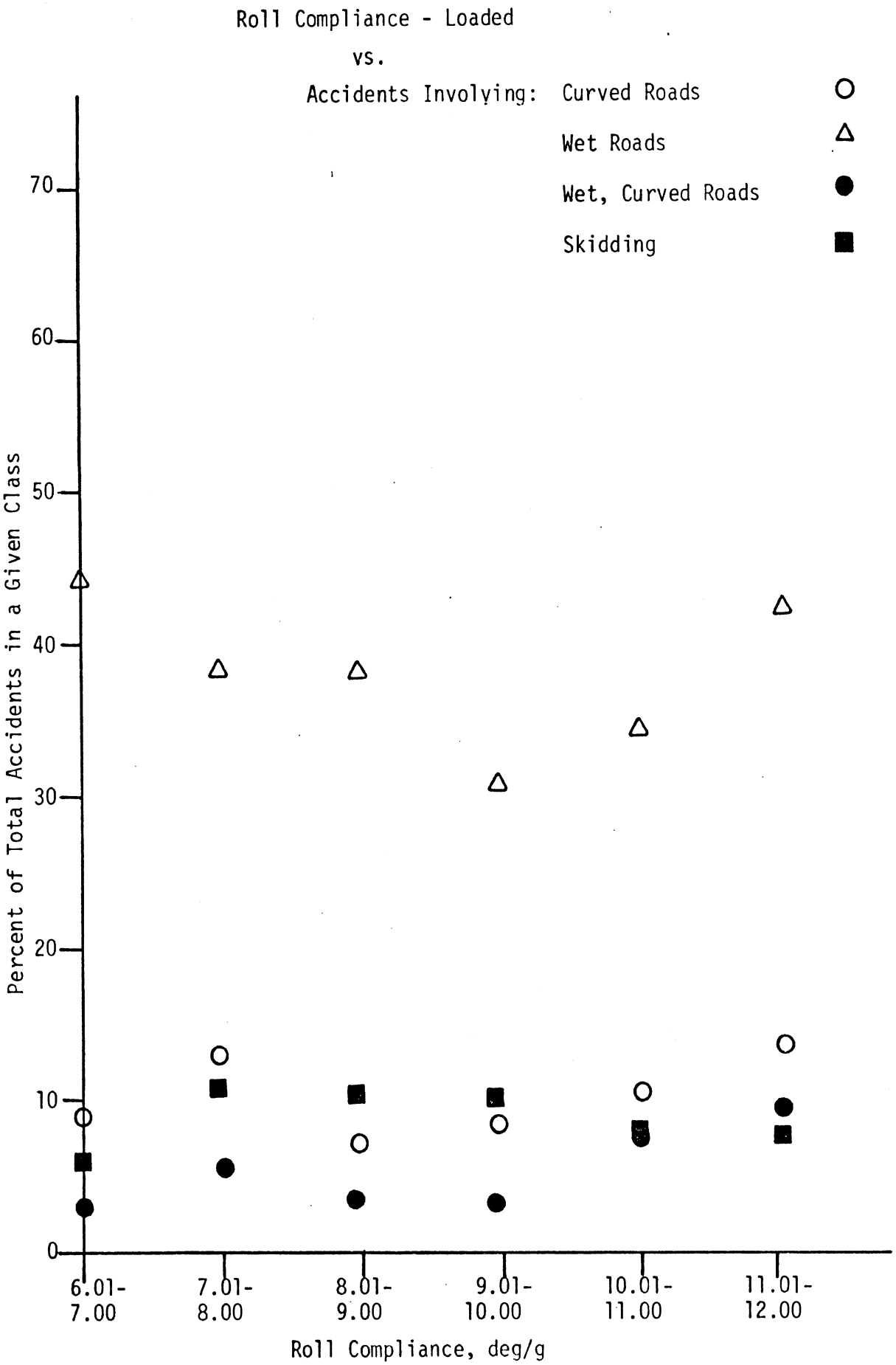

Roll Compliance - Loaded
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
6.01-
7.00
7.01-
8.00
8.01-
9.00
9.01-
10.00
10.01-
11.00
11.01-
12.00
Roll Compliance, deg/g

Figure E.33

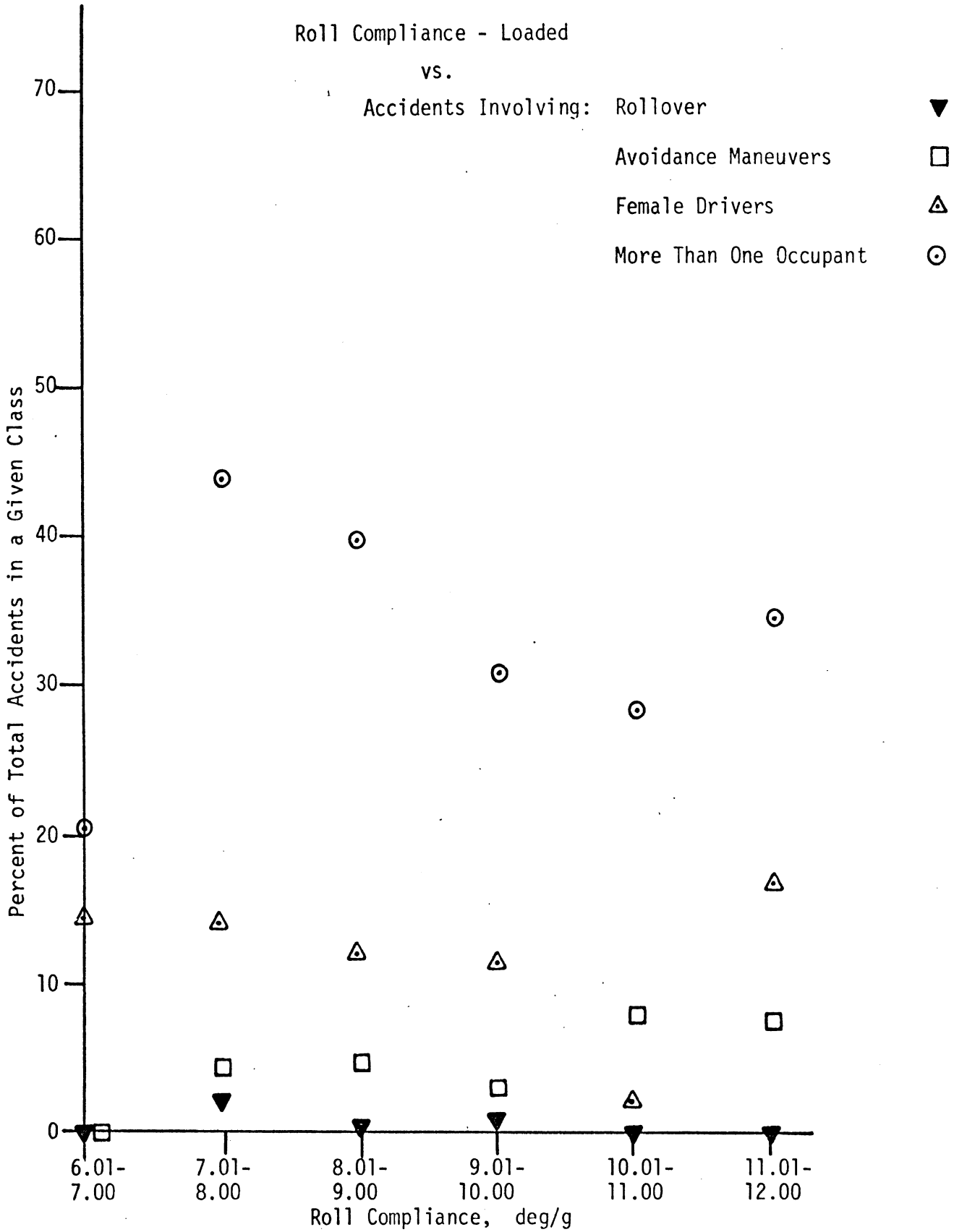

Roll Compliance - Loaded
vs.
Accidents Involving: Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
70
60
50
40
30
20
10
0
6.01-7.00
7.01-8.00
8.01-9.00
9.01-10.00
10.01-11.00
11.01-12.00
Roll Compliance, deg/g

Figure E.34

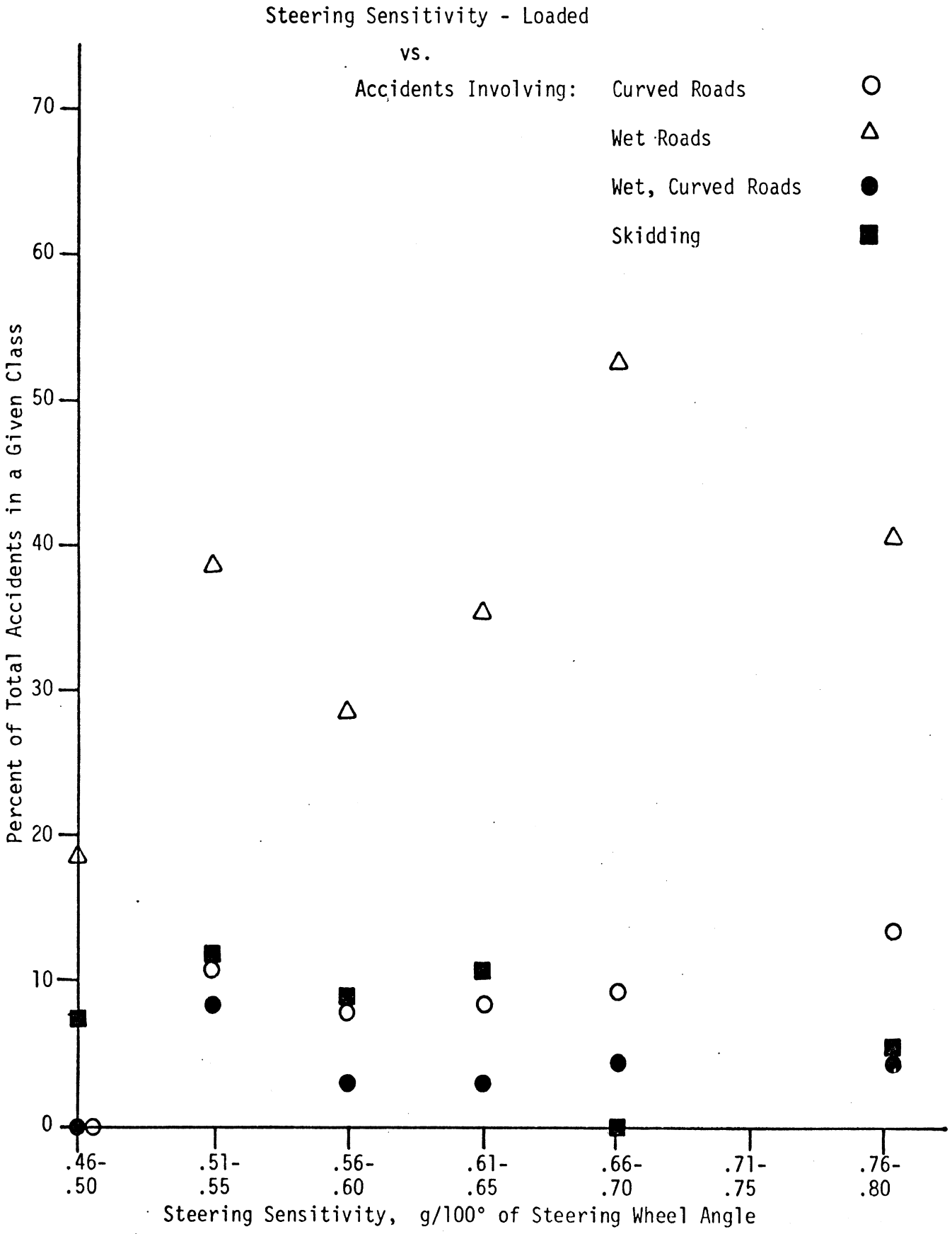

Steering Sensitivity - Loaded
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
.46-
.50
.51-
.55
.56-
.60
.61-
.65
.66-
.70
.71-
.75
.76-
.80
Steering Sensitivity, g/100° of Steering Wheel Angle

Figure E.35

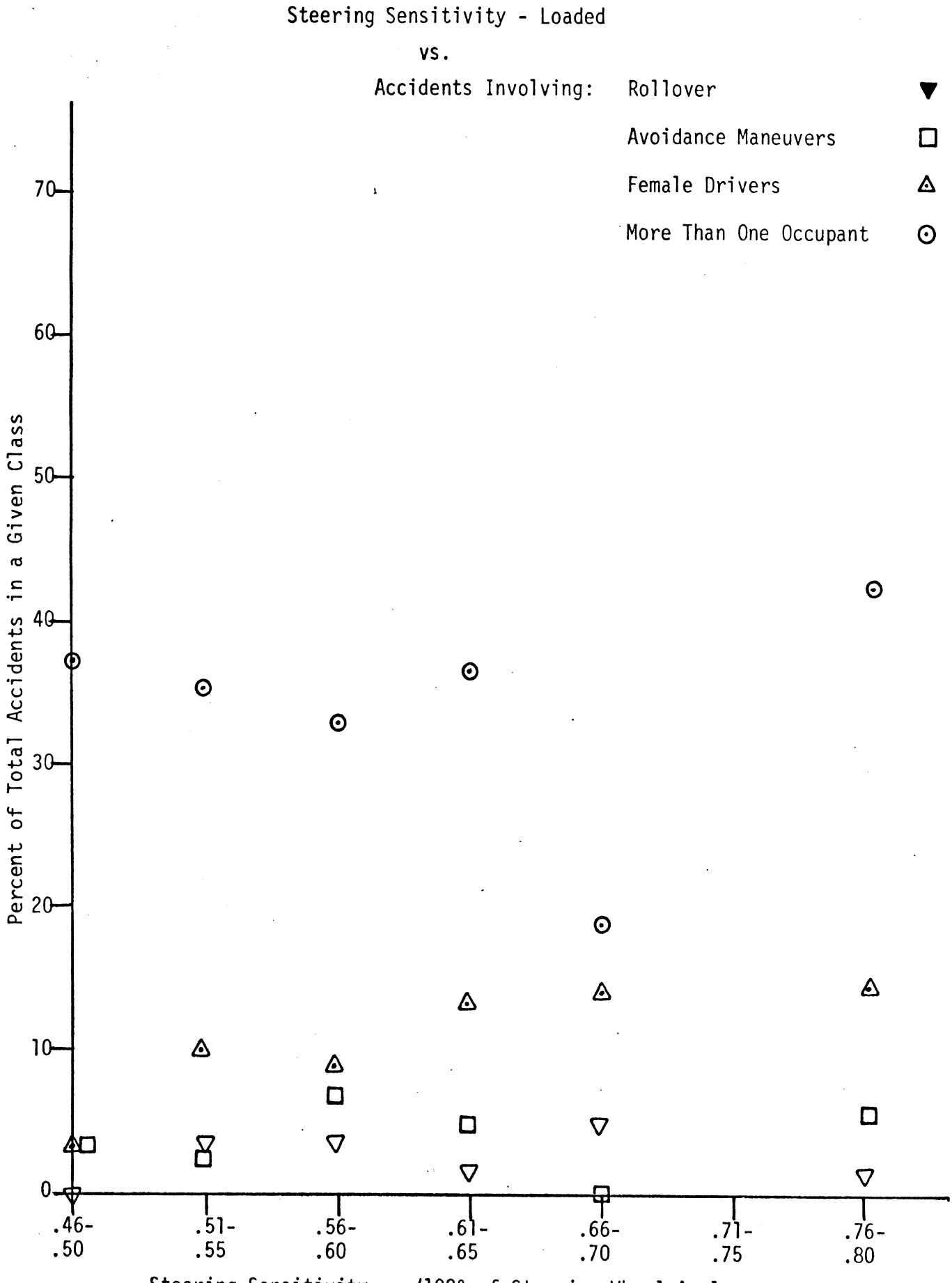

Steering Sensitivity - Loaded
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
.46-
.50
.51-
.55
.56-
.60
.61-
.65
.66-
.70
.71-
.75
.76-
.80
Steering Sensitivity, g/100° of Steering Wheel Angle

Figure E.36

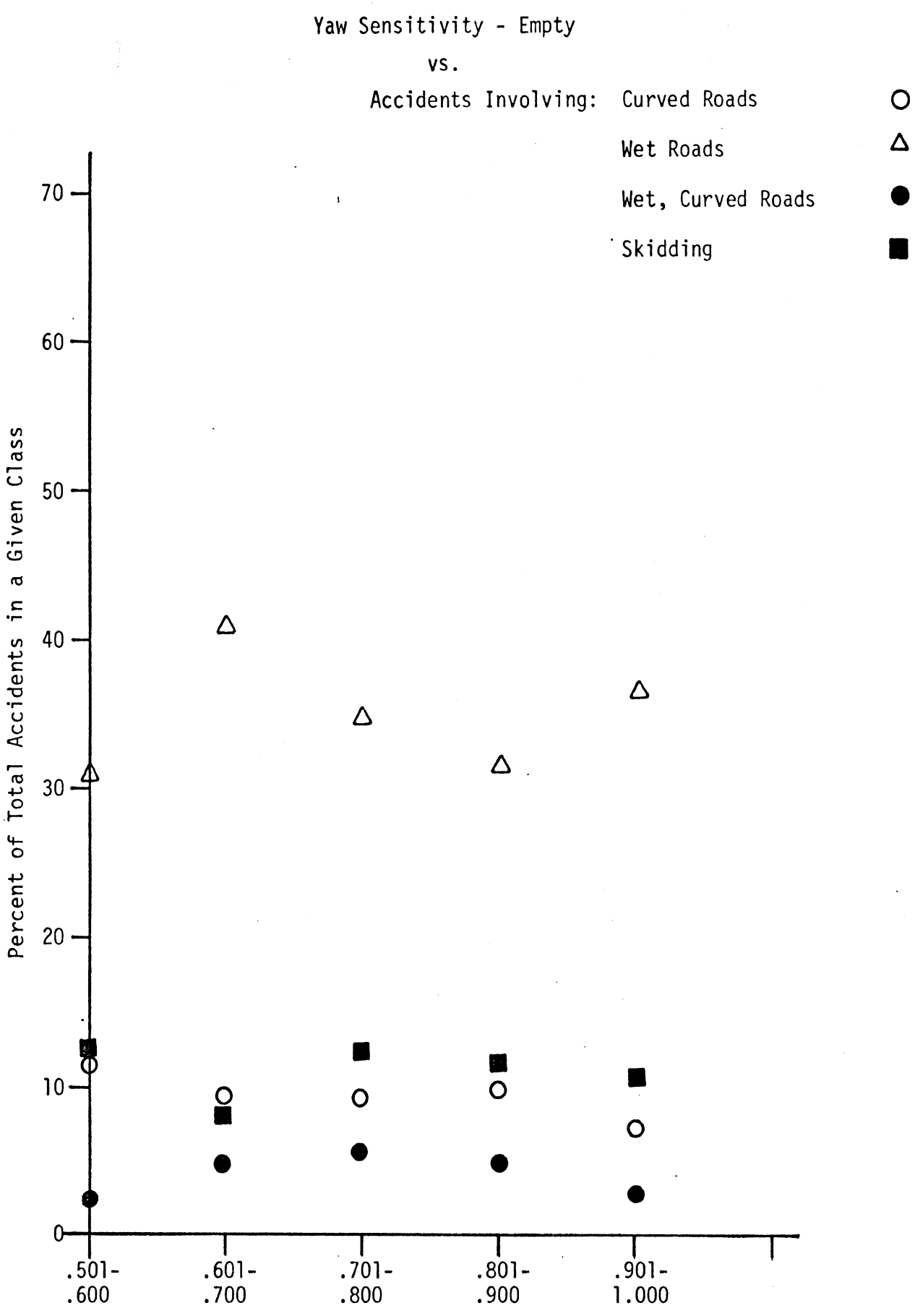

Yaw Sensitivity - Empty
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
70
60
50
40
30
20
10
0
.501-
.600
.601-
.700
.701-
.800
.801-
.900
.901-
1.000
Yaw Sensitivity, Yaw Acceleration/Deg. of Steering Wheel Angle

Figure E.37

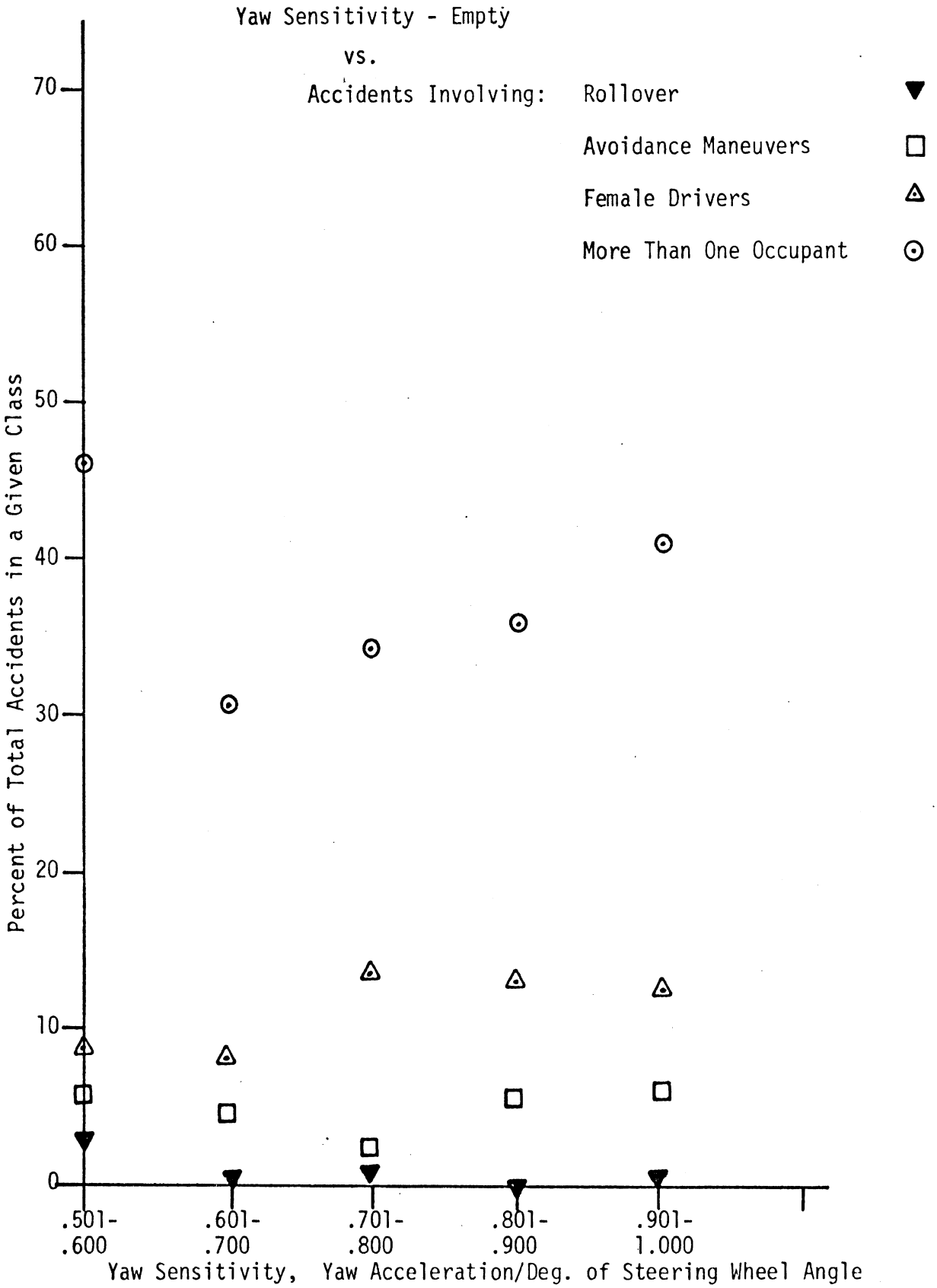

Yaw Sensitivity - Empty
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
70
60
50
40
30
20
10
0
.501-
.600
.601-
.700
.701-
.800
.801-
.900
.901-
1.000
Yaw Sensitivity, Yaw Acceleration/Deg. of Steering Wheel Angle

Figure E.38

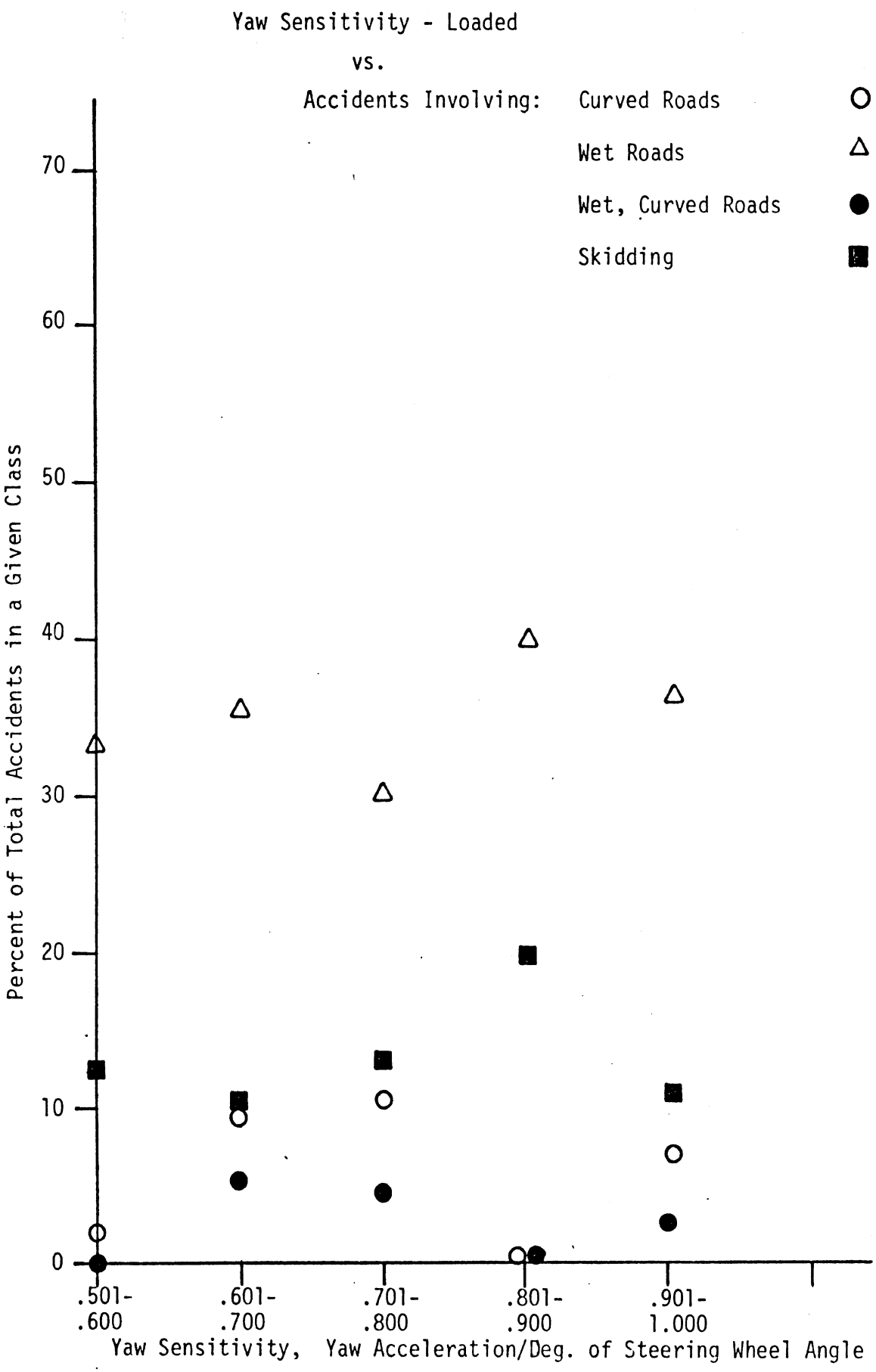

Yaw Sensitivity - Loaded
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
70
60
50
40
30
20
10
0
.501-
.600
.601-
.700
.701-
.800
.801-
.900
.901-
1.000
Yaw Sensitivity, Yaw Acceleration/Deg. of Steering Wheel Angle

Figure E.39

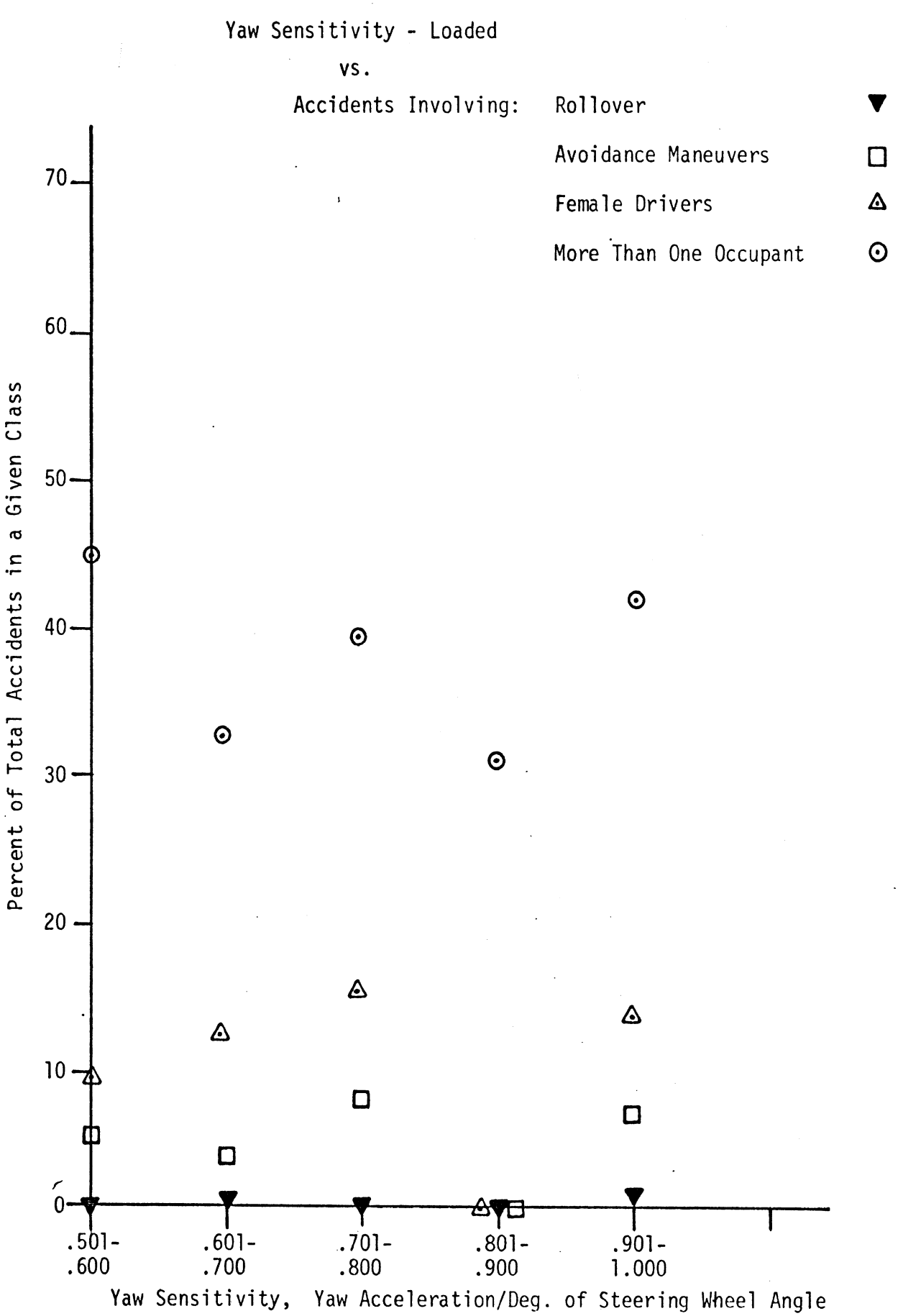

Yaw Sensitivity - Loaded
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
70
60
50
40
30
20
10
0
.501-
.600
.601-
.700
.701-
.800
.801-
.900
.901-
1.000
Yaw Sensitivity, Yaw Acceleration/Deg. of Steering Wheel Angle

Figure E.40

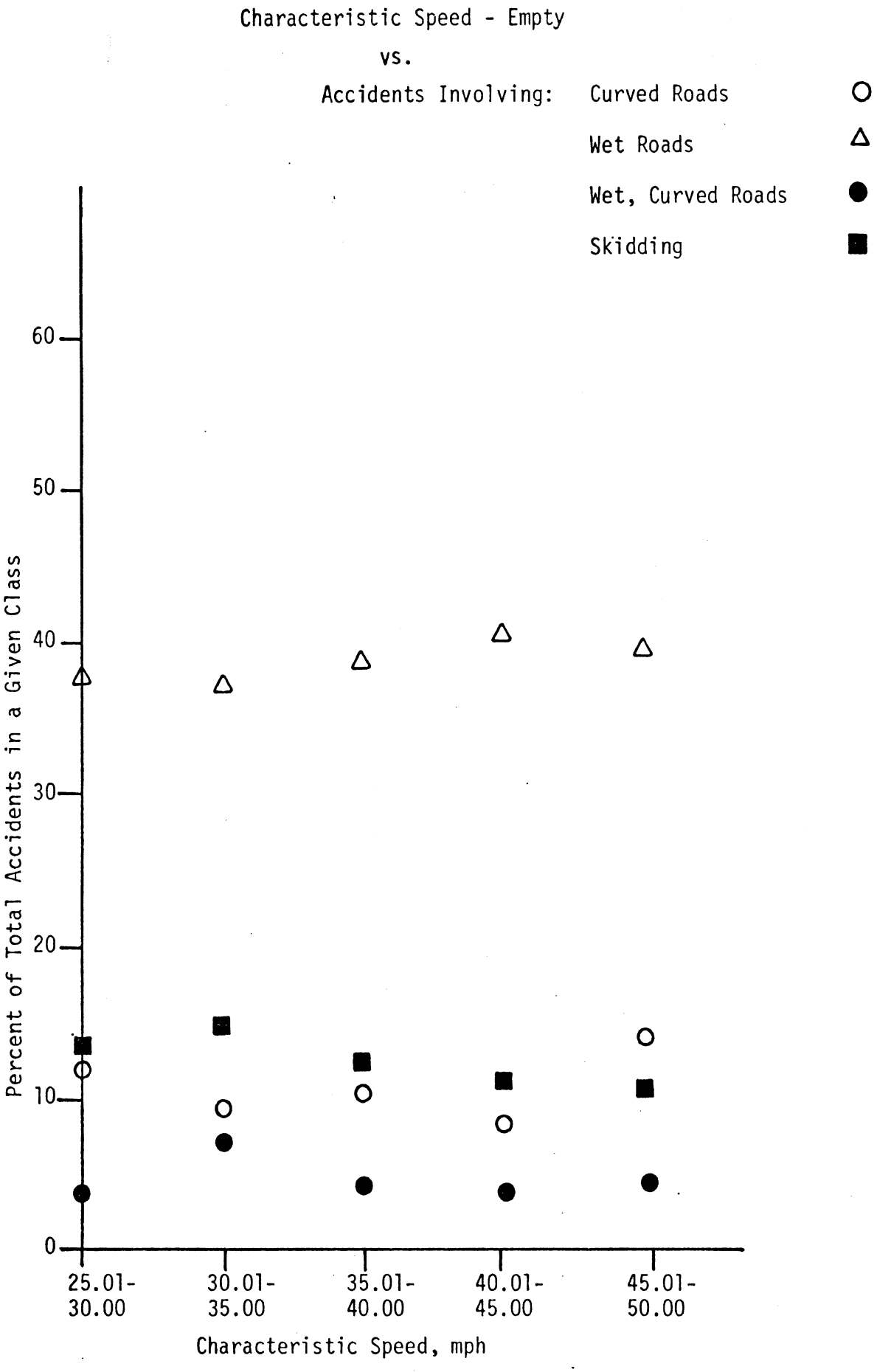

Characteristic Speed - Empty
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
25.01-
30.00
30.01-
35.00
35.01-
40.00
40.01-
45.00
45.01-
50.00
Characteristic Speed, mph

Figure E.41

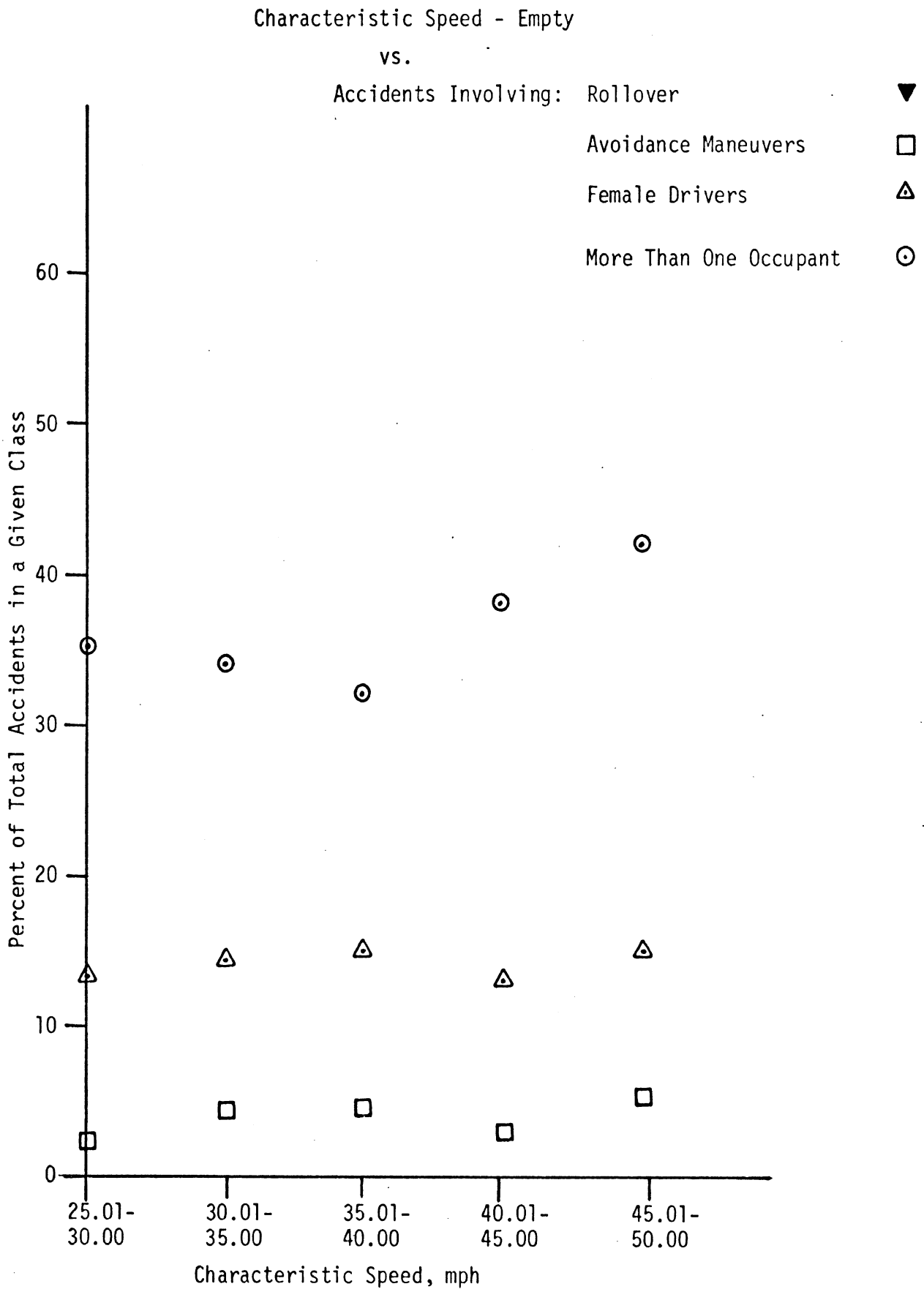

Characteristic Speed - Empty
vs.
Accidents Involving: Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
25.01-30.00
30.01-35.00
35.01-40.00
40.01-45.00
45.01-50.00
Characteristic Speed, mph

Figure E.42

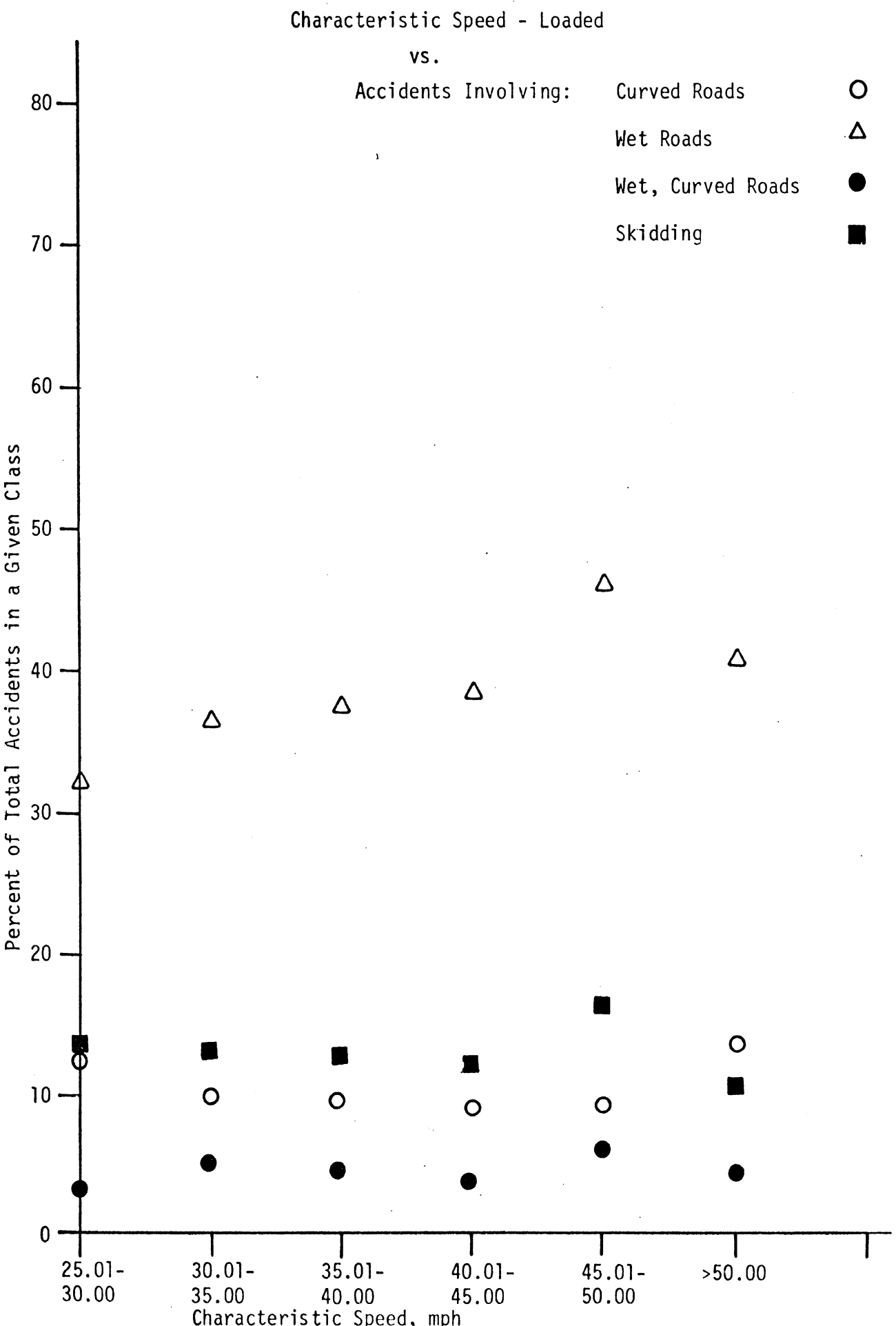

Characteristic Speed - Loaded
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
25.01-30.00
30.01-35.00
35.01-40.00
40.01-45.00
45.01-50.00
>50.00
Characteristic Speed, mph

Figure E.43

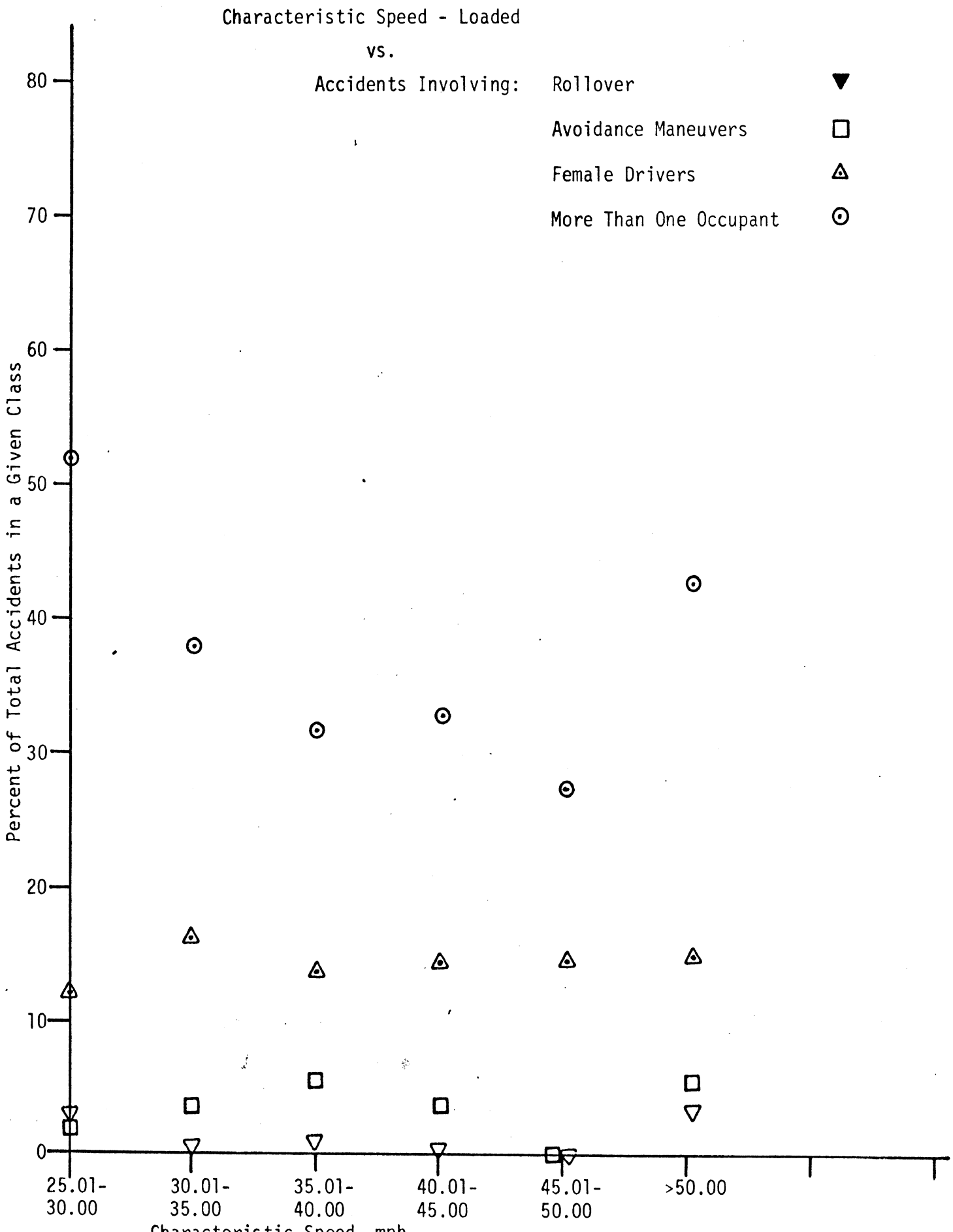

Characteristic Speed - Loaded
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
25.01-30.00
30.01-35.00
35.01-40.00
40.01-45.00
45.01-50.00
>50.00
Characteristic Speed, mph

Figure E.44

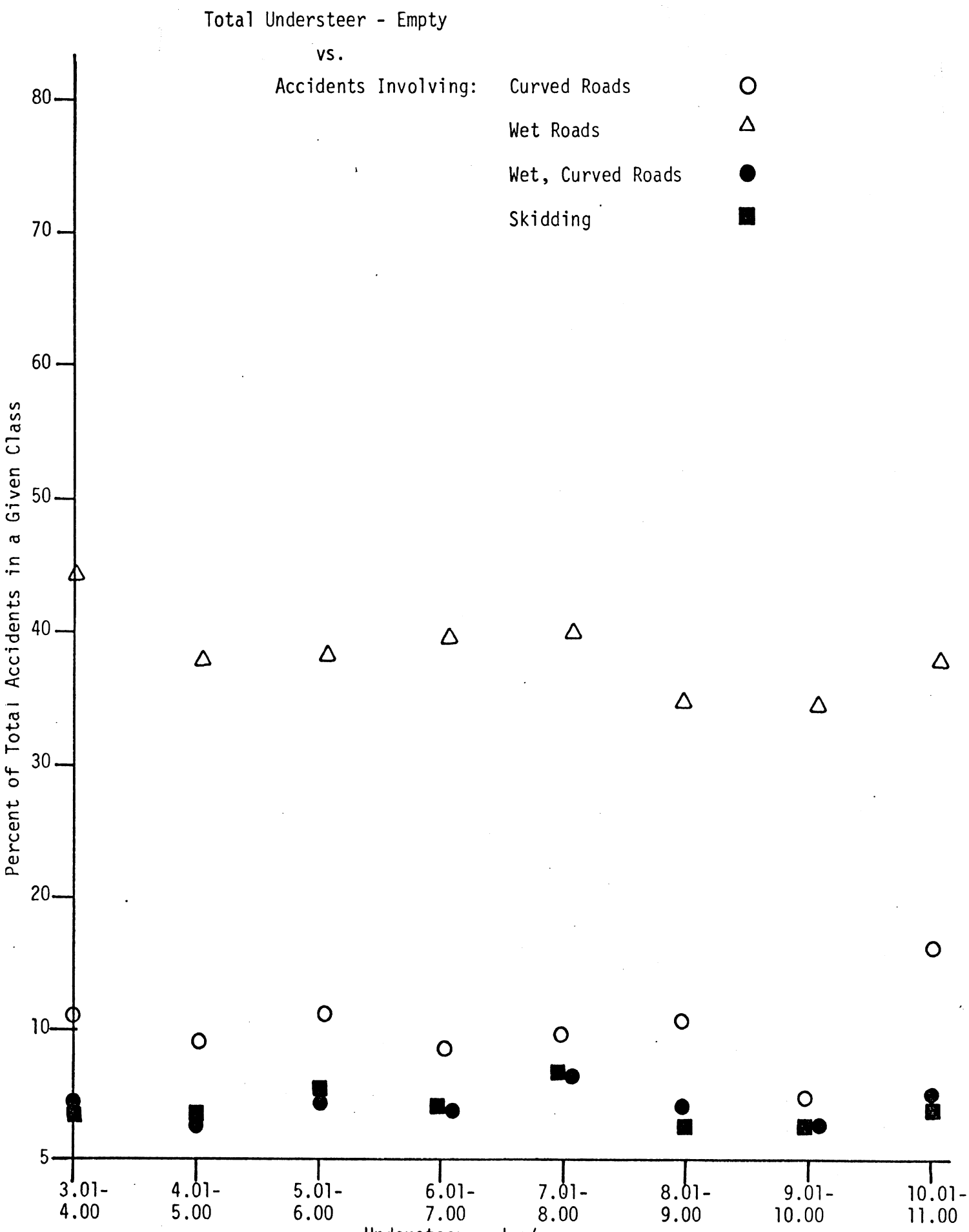

Total Understeer - Empty
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
80
70
60
50
40
30
20
10
5
3.01-4.00
4.01-5.00
5.01-6.00
6.01-7.00
7.01-8.00
8.01-9.00
9.01-10.00
10.01-11.00
Understeer, deg/g

Figure E.45

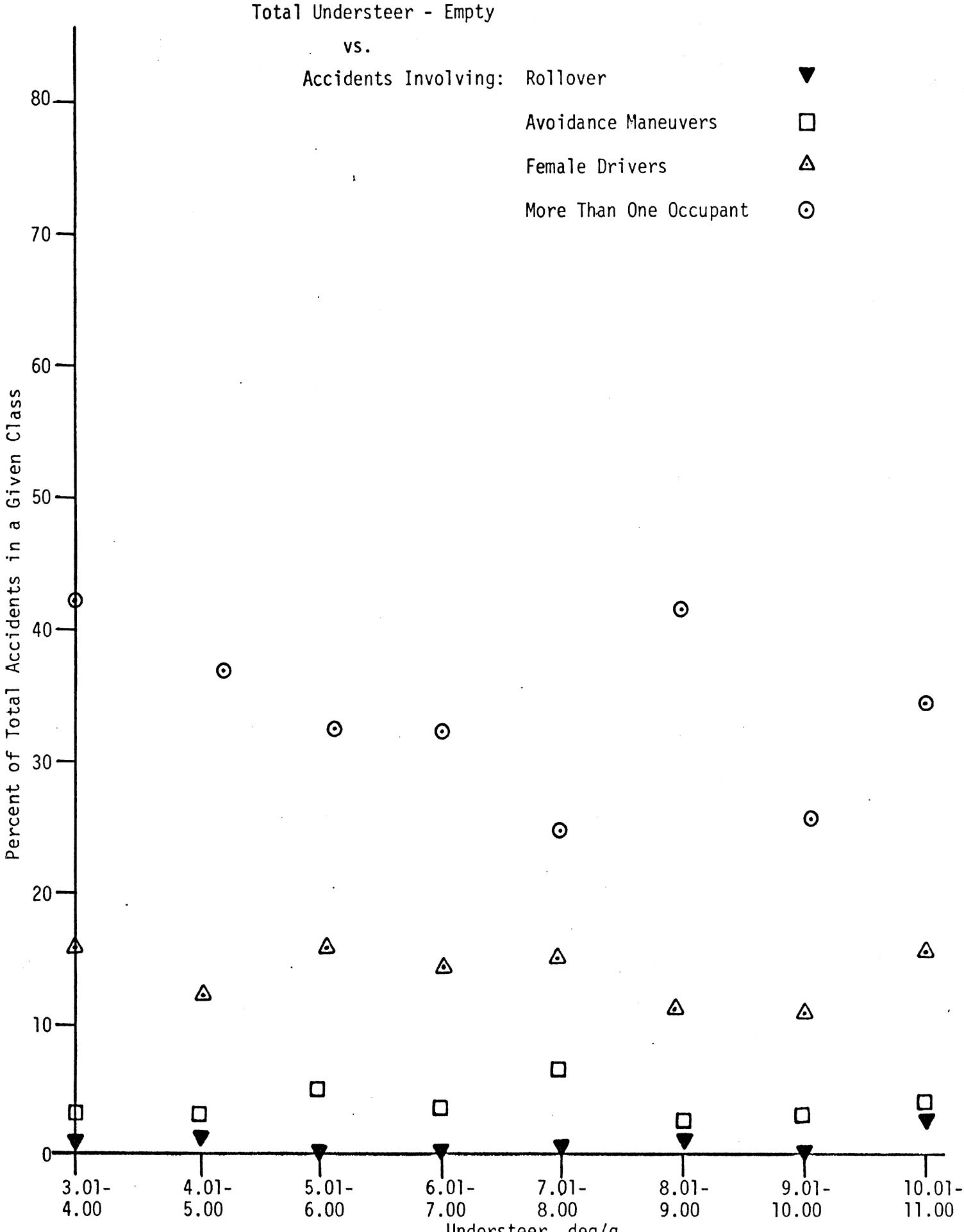

Total Understeer - Empty
vs.
Accidents Involving: Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
3.01-4.00
4.01-5.00
5.01-6.00
6.01-7.00
7.01-8.00
8.01-9.00
9.01-10.00
10.01-11.00
Understeer, deg/g

Figure E.46

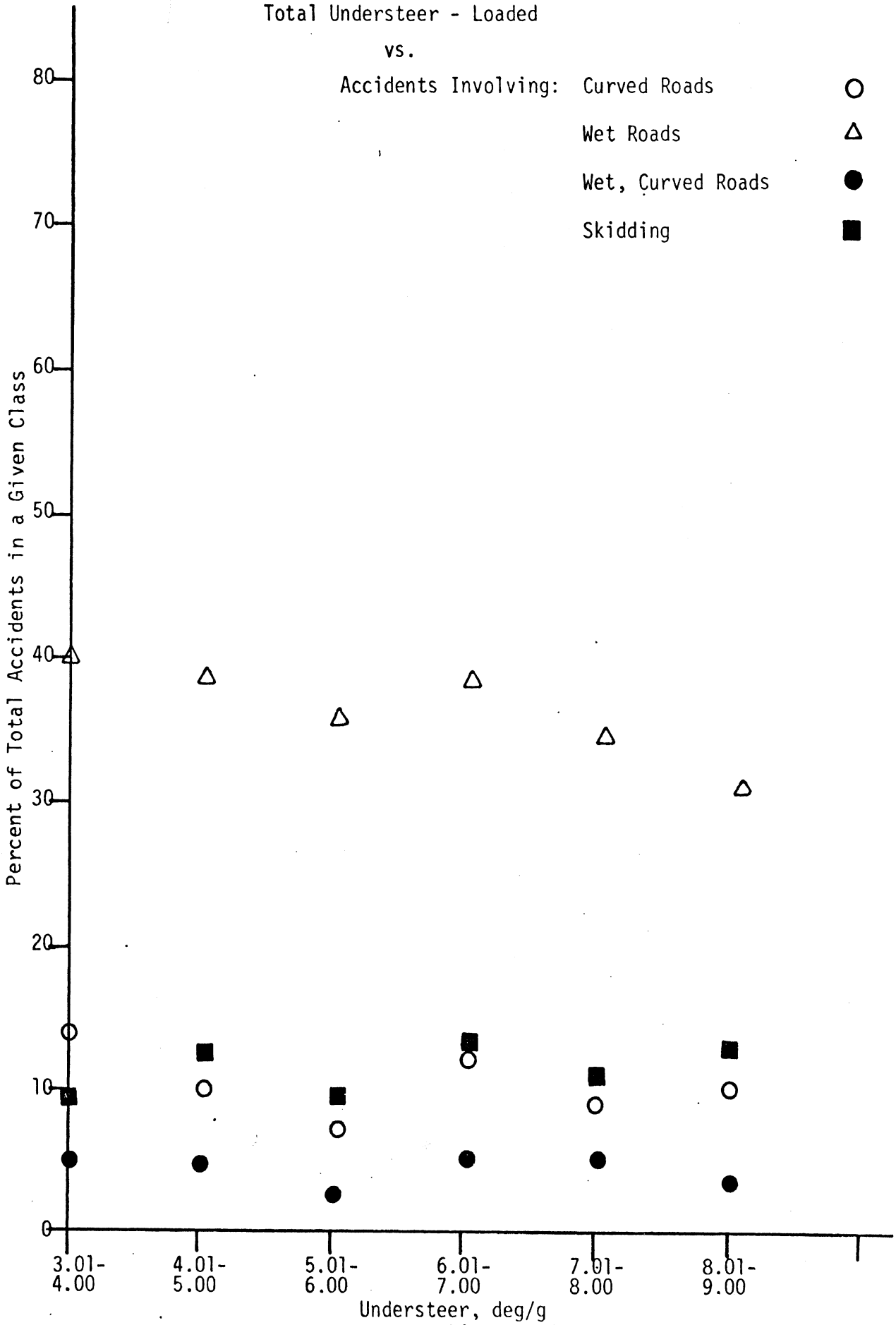

Total Understeer - Loaded
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
3.01-4.00
4.01-5.00
5.01-6.00
6.01-7.00
7.01-8.00
8.01-9.00
Understeer, deg/g

Figure E.47

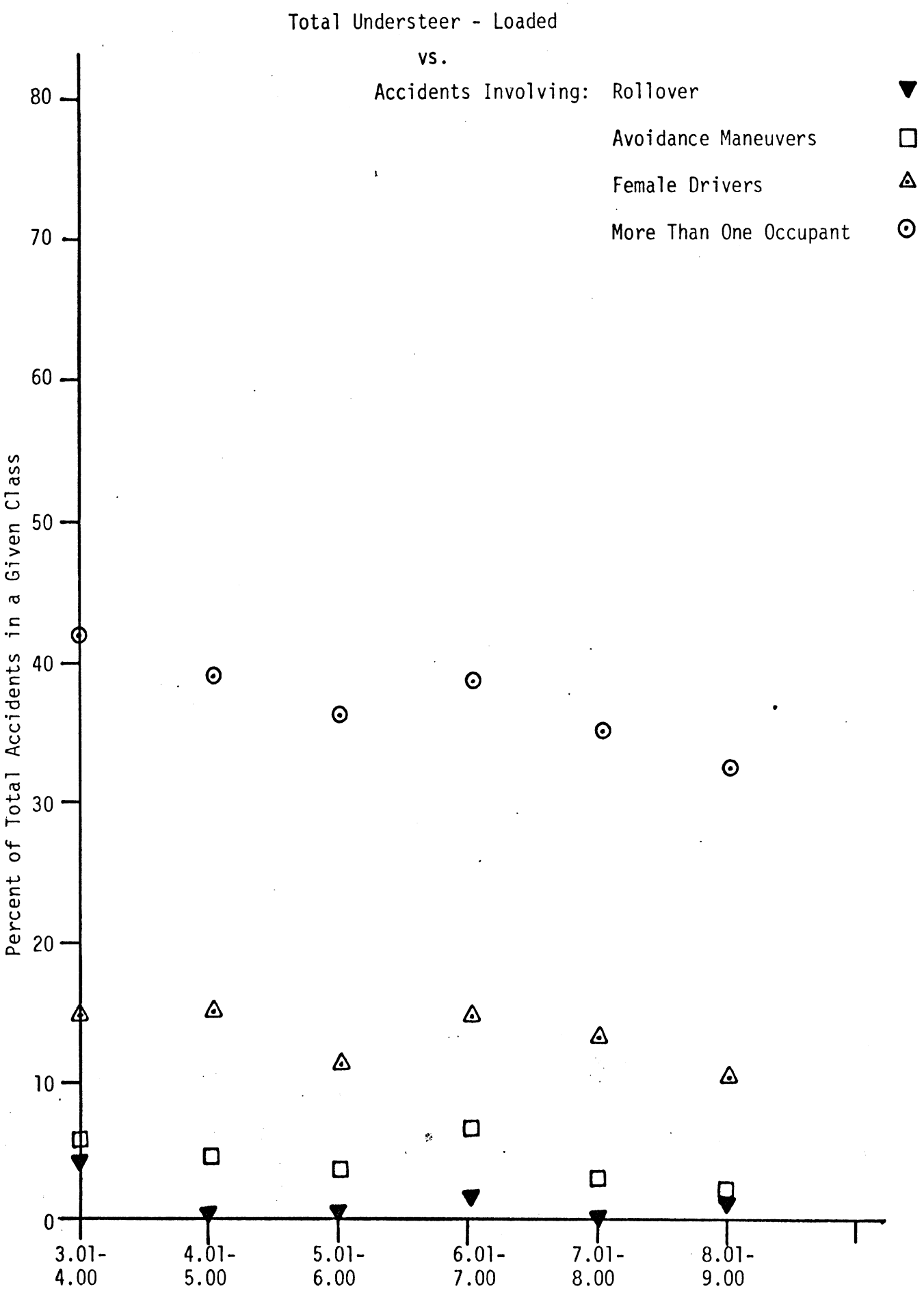

Total Understeer - Loaded
vs.
Accidents Involving: Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
80
70
60
50
40
30
20
10
0
3.01-
4.00
4.01-
5.00
5.01-
6.00
6.01-
7.00
7.01-
8.00
8.01-
9.00
Understeer, deg/g

Figure E.48

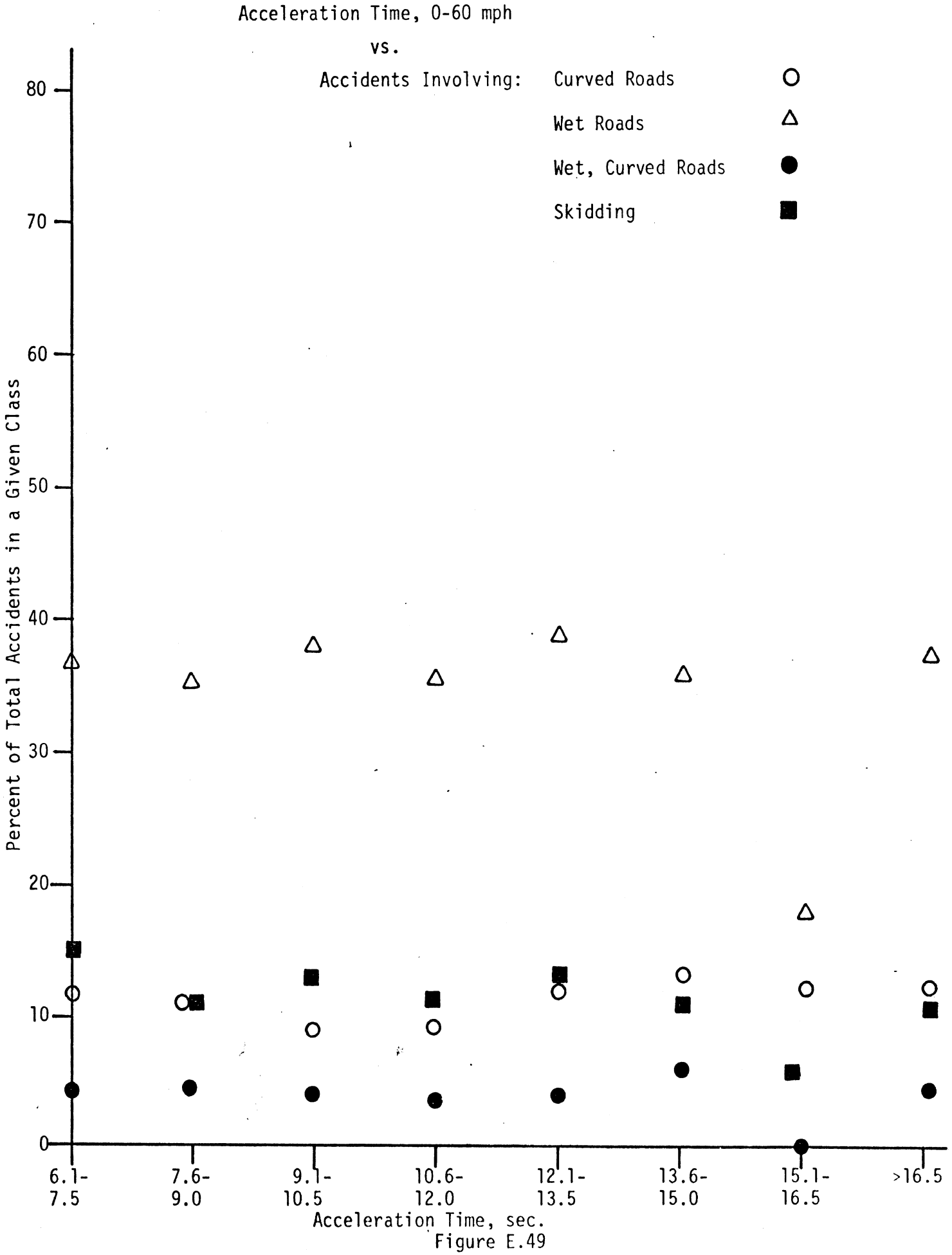

Acceleration Time, 0-60 mph
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
6.1-7.5
7.6-9.0
9.1-10.5
10.6-12.0
12.1-13.5
13.6-15.0
15.1-16.5
>16.5
Acceleration Time, sec.

Figure E.49

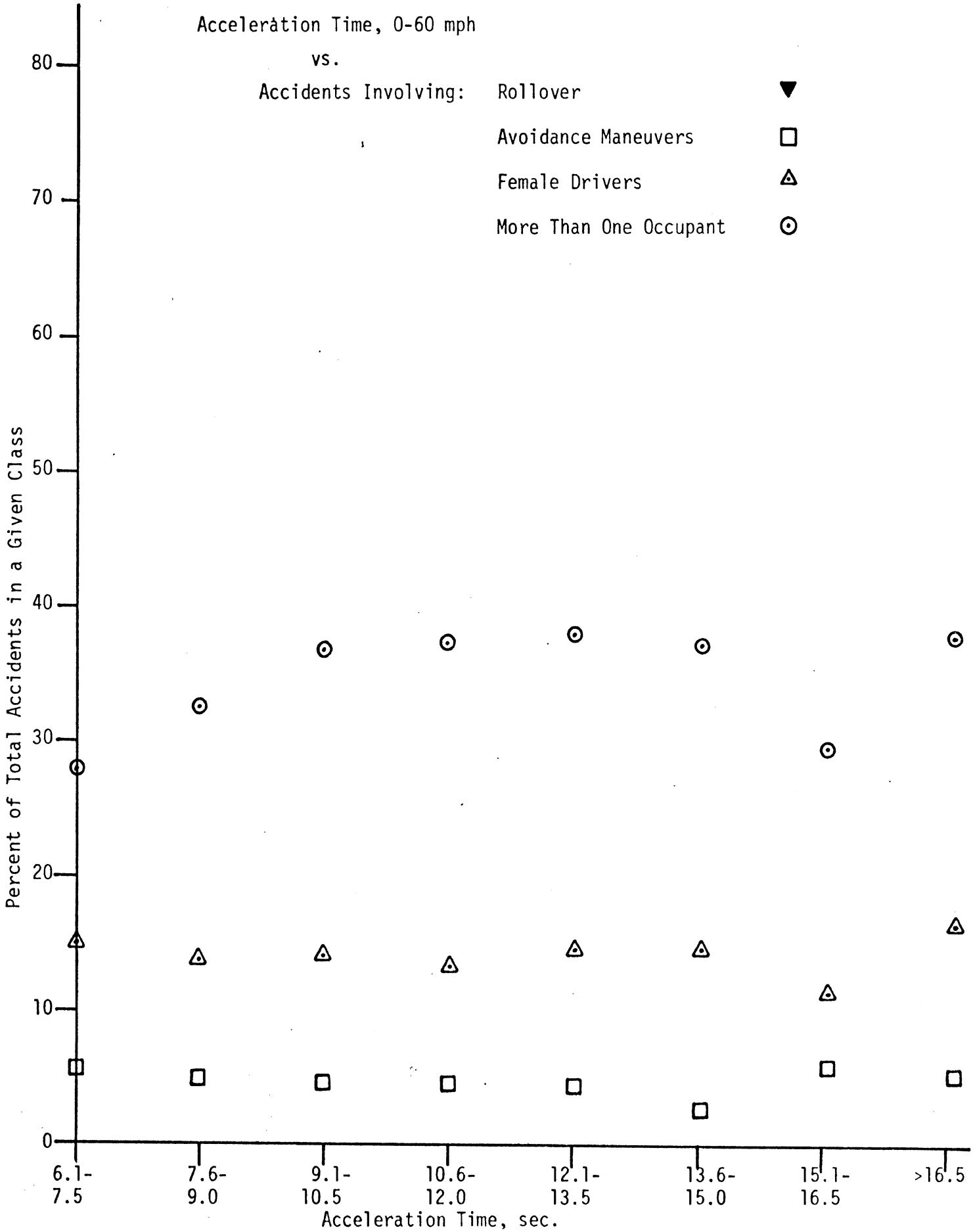

Acceleration Time, 0-60 mph
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
6.1-7.5
7.6-9.0
9.1-10.5
10.6-12.0
12.1-13.5
13.6-15.0
15.1-16.5
>16.5
Acceleration Time, sec.

Figure E.50

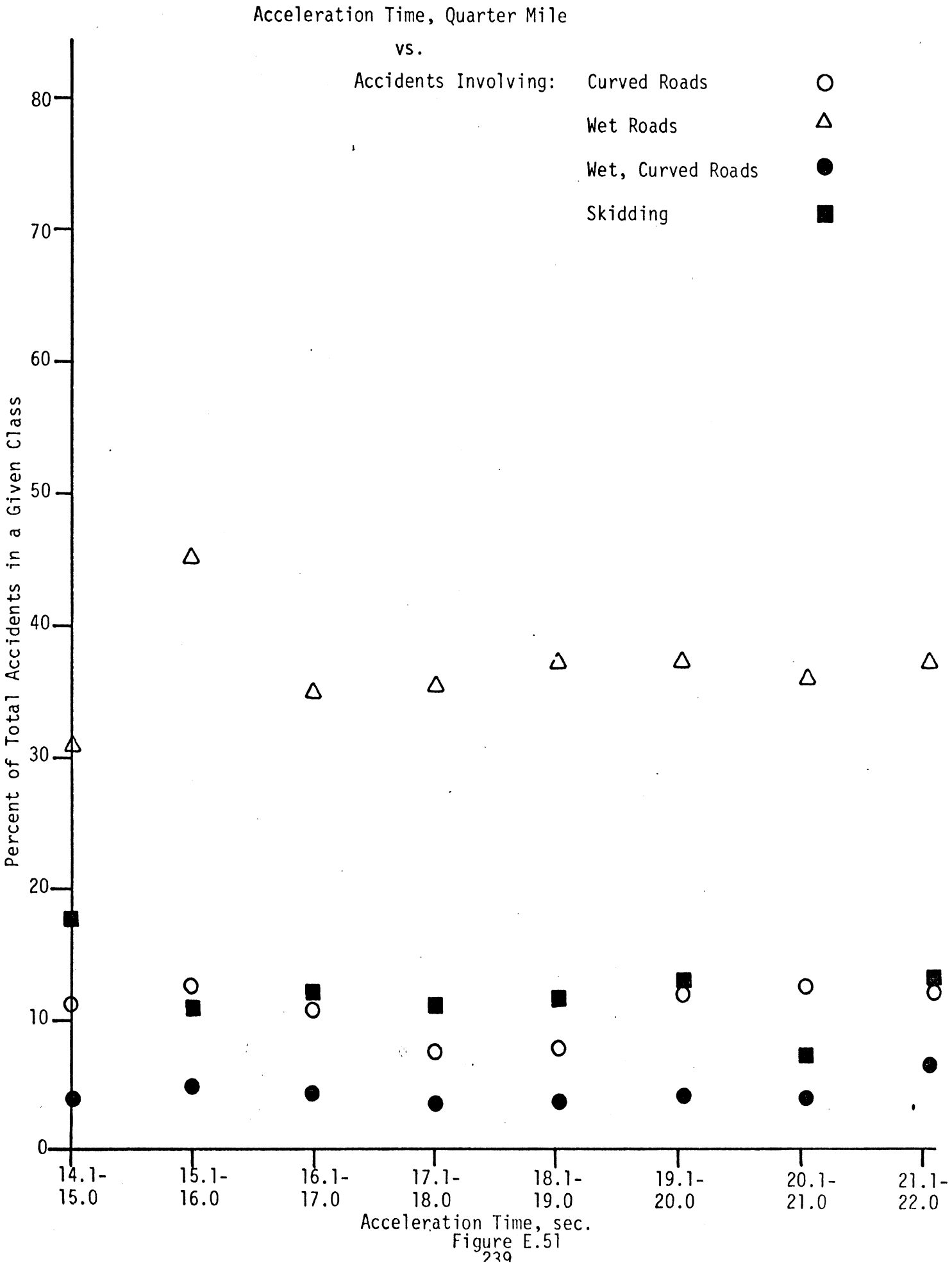

Acceleration Time, Quarter Mile
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
14.1-15.0
15.1-16.0
16.1-17.0
17.1-18.0
18.1-19.0
19.1-20.0
20.1-21.0
21.1-22.0
Acceleration Time, sec.

Figure E.51

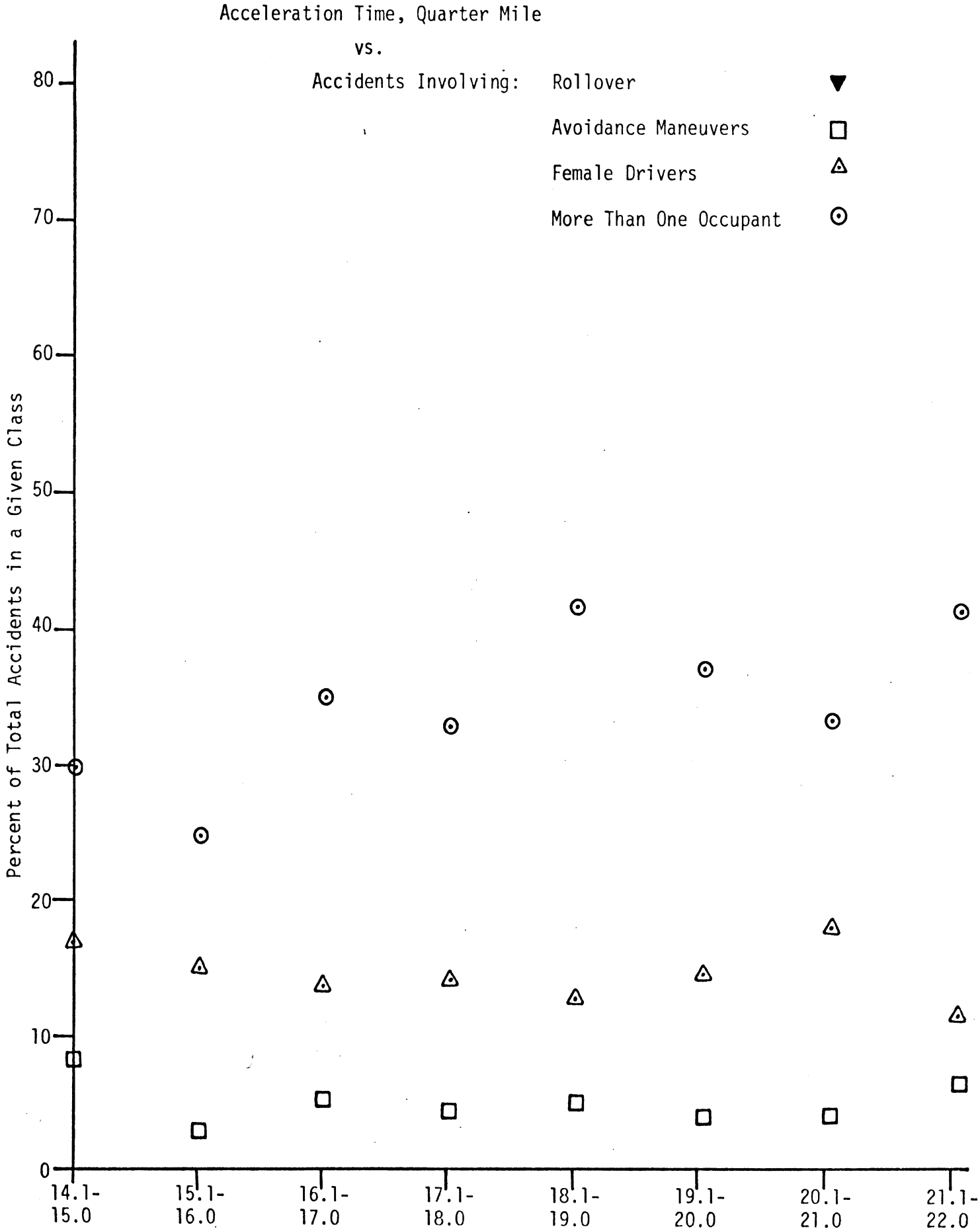

Acceleration Time, Quarter Mile
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
14.1-15.0
15.1-16.0
16.1-17.0
17.1-18.0
18.1-19.0
19.1-20.0
20.1-21.0
21.1-22.0
Acceleration Time, sec.

Figure E.52

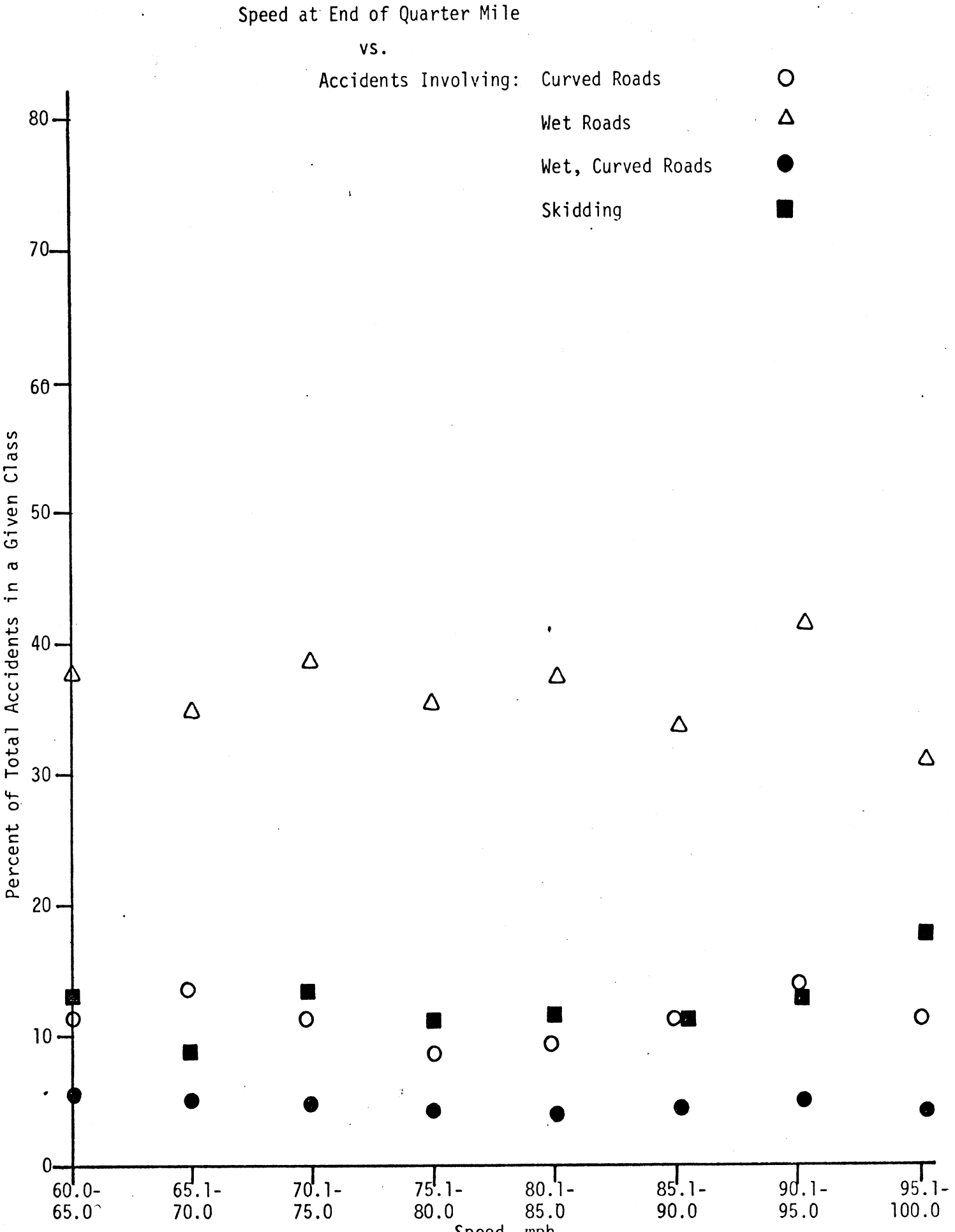

Speed at End of Quarter Mile
vs.
Accidents Involving: Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
60.0-65.0
65.1-70.0
70.1-75.0
75.1-80.0
80.1-85.0
85.1-90.0
90.1-95.0
95.1-100.0
Speed, mph

Figure E.53

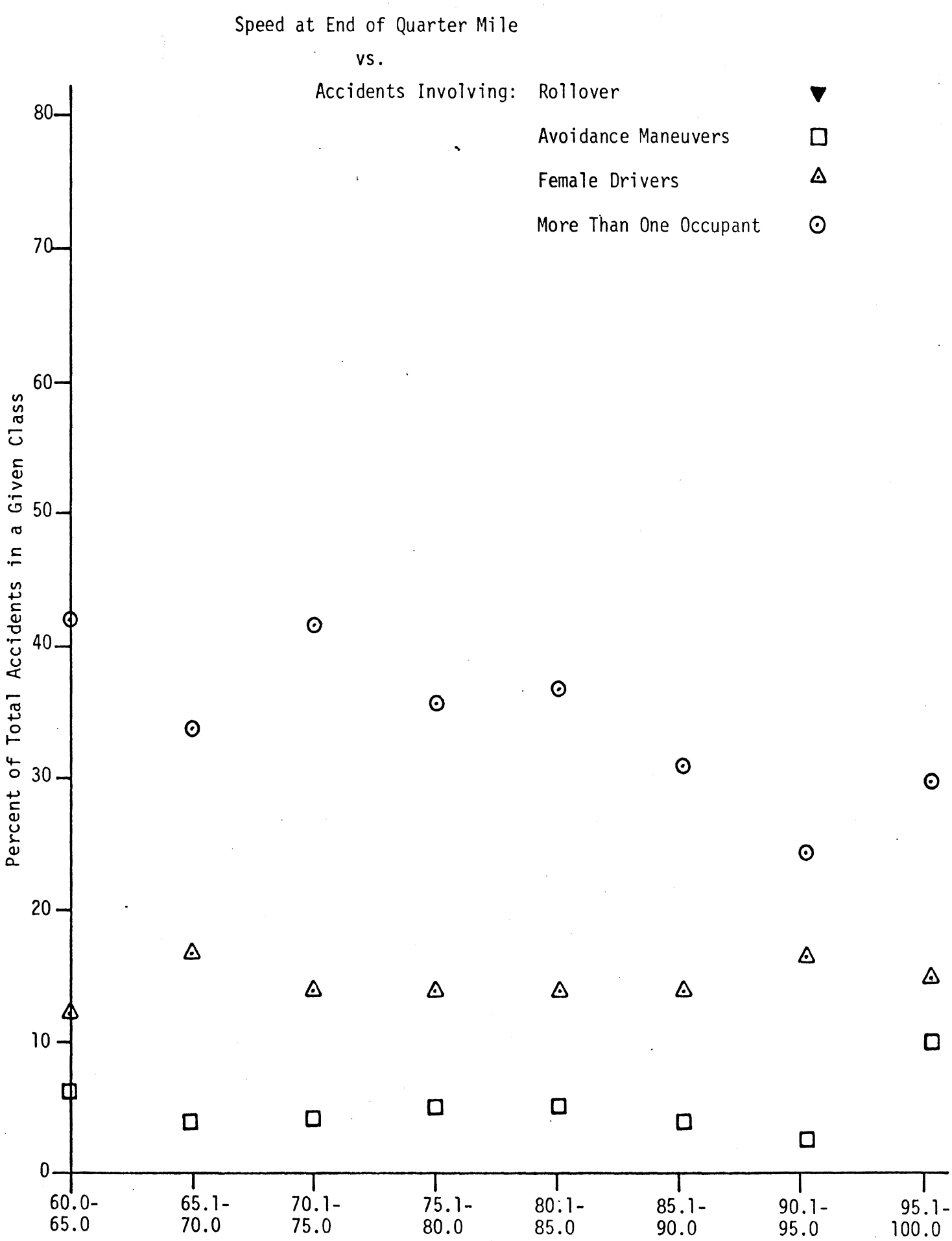

Speed at End of Quarter Mile
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
60.0-65.0
65.1-70.0
70.1-75.0
75.1-80.0
80.1-85.0
85.1-90.0
90.1-95.0
95.1-100.0
Speed, mph

Figure E.54

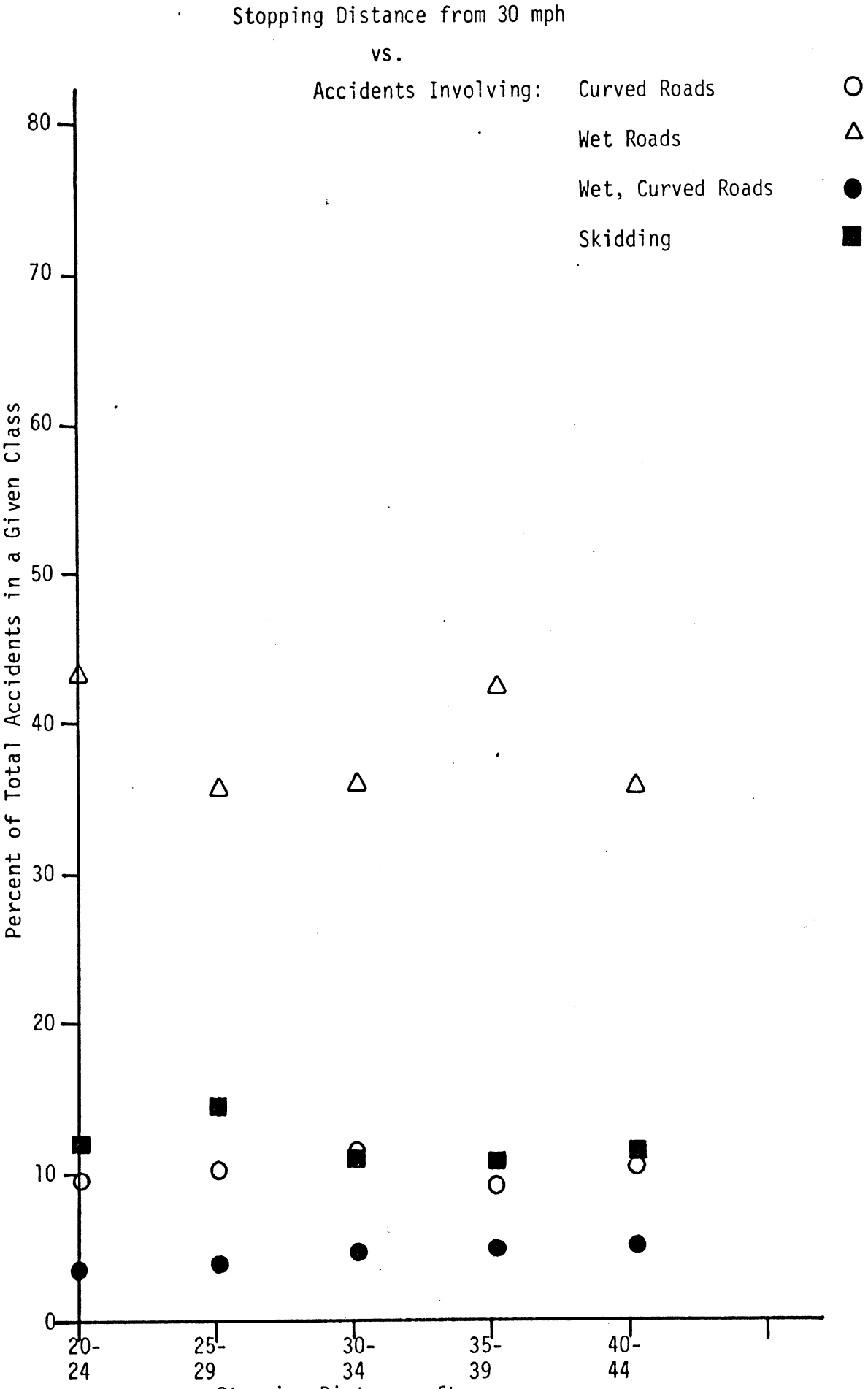

Stopping Distance from 30 mph
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
20-24
25-29
30-34
35-39
40-44
Stopping Distance, ft.

Figure E.55

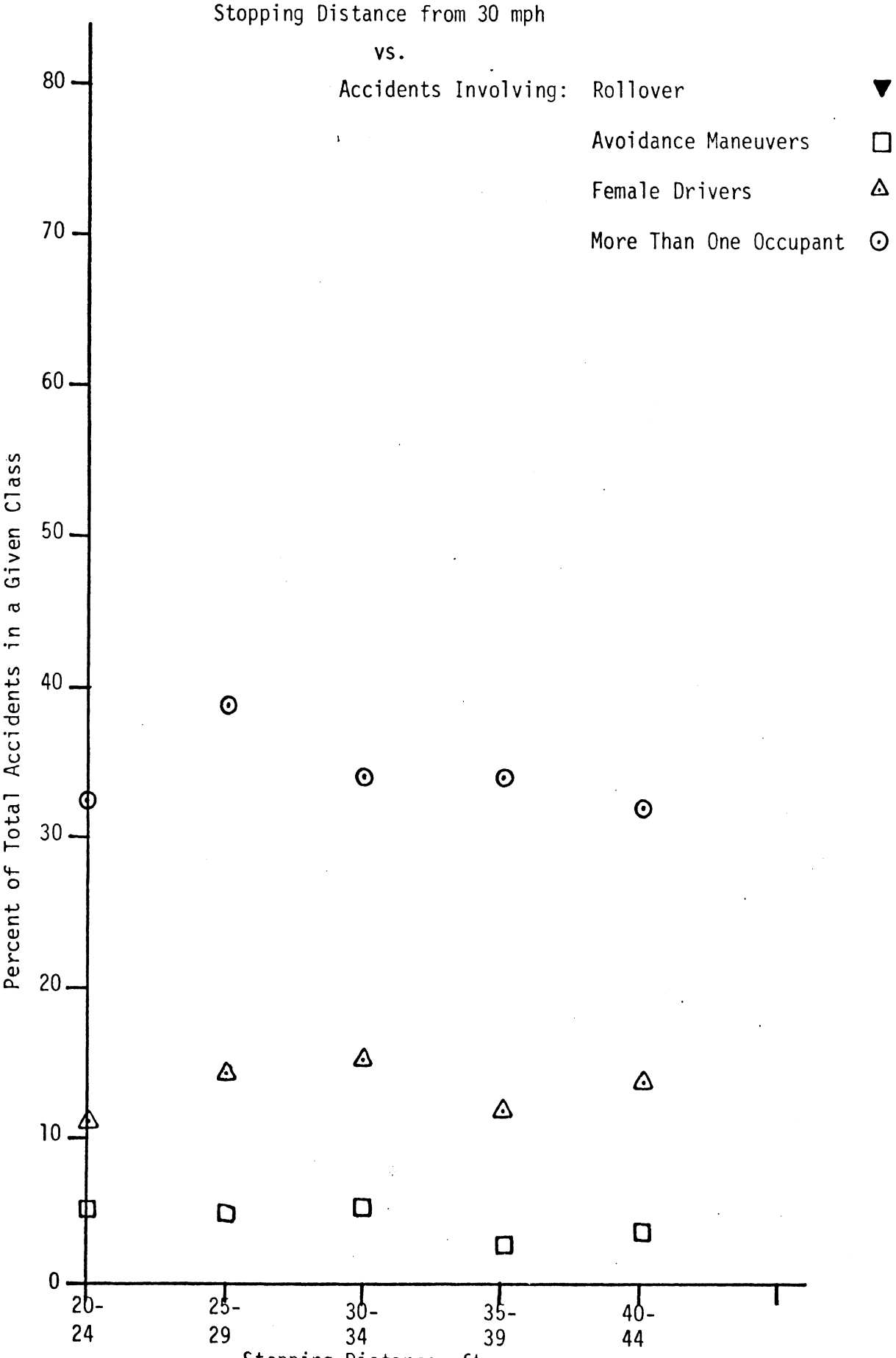

Stopping Distance from 30 mph
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
80
70
60
50
40
30
20
10
0
20-24
25-29
30-34
35-39
40-44
Stopping Distance, ft.

Figure E.56

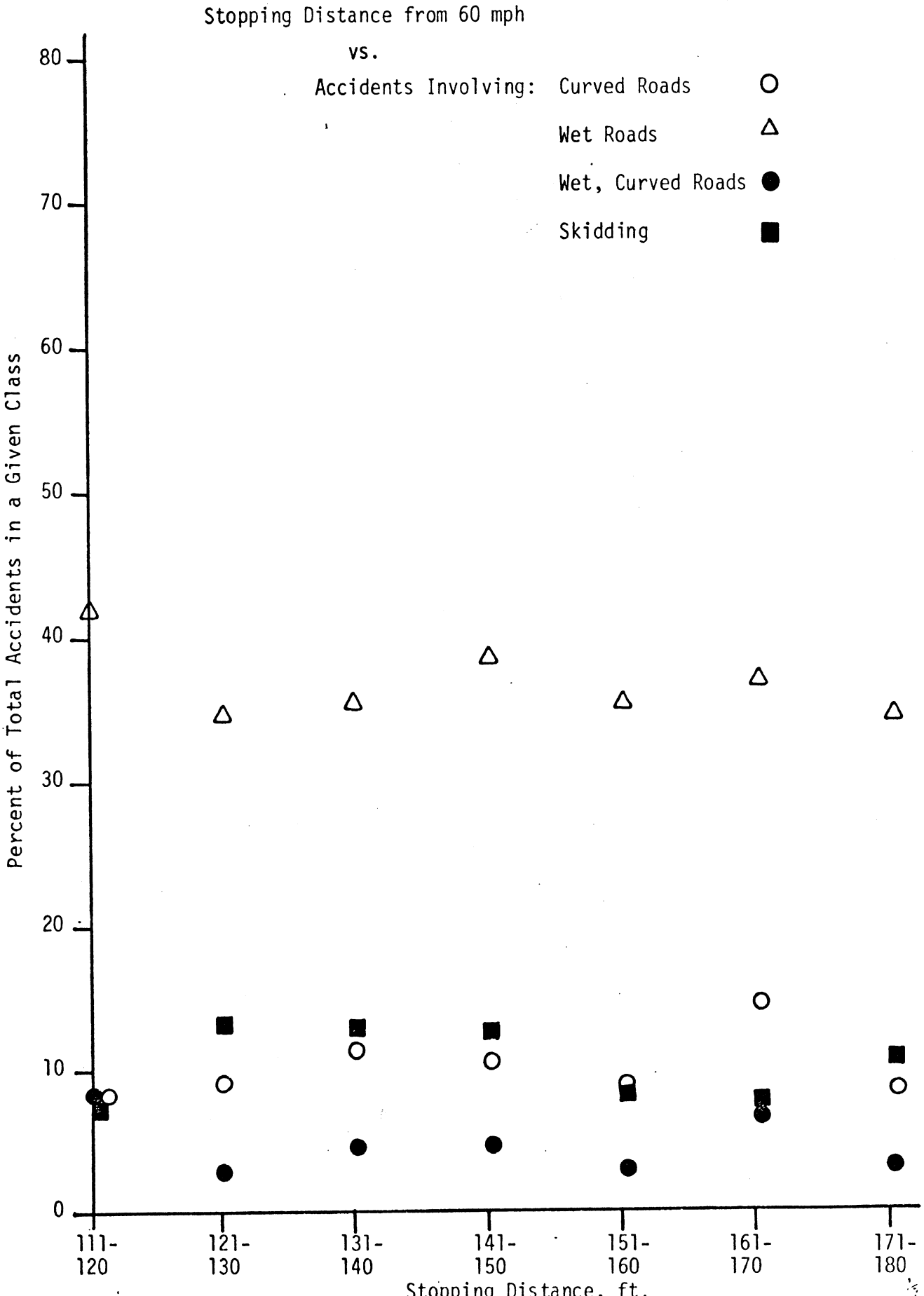

Stopping Distance from 60 mph
vs.
Accidents Involving:
Curved Roads
Wet Roads
Wet, Curved Roads
Skidding
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
111-120
121-130
131-140
141-150
151-160
161-170
171-180
Stopping Distance, ft.

Figure E.57

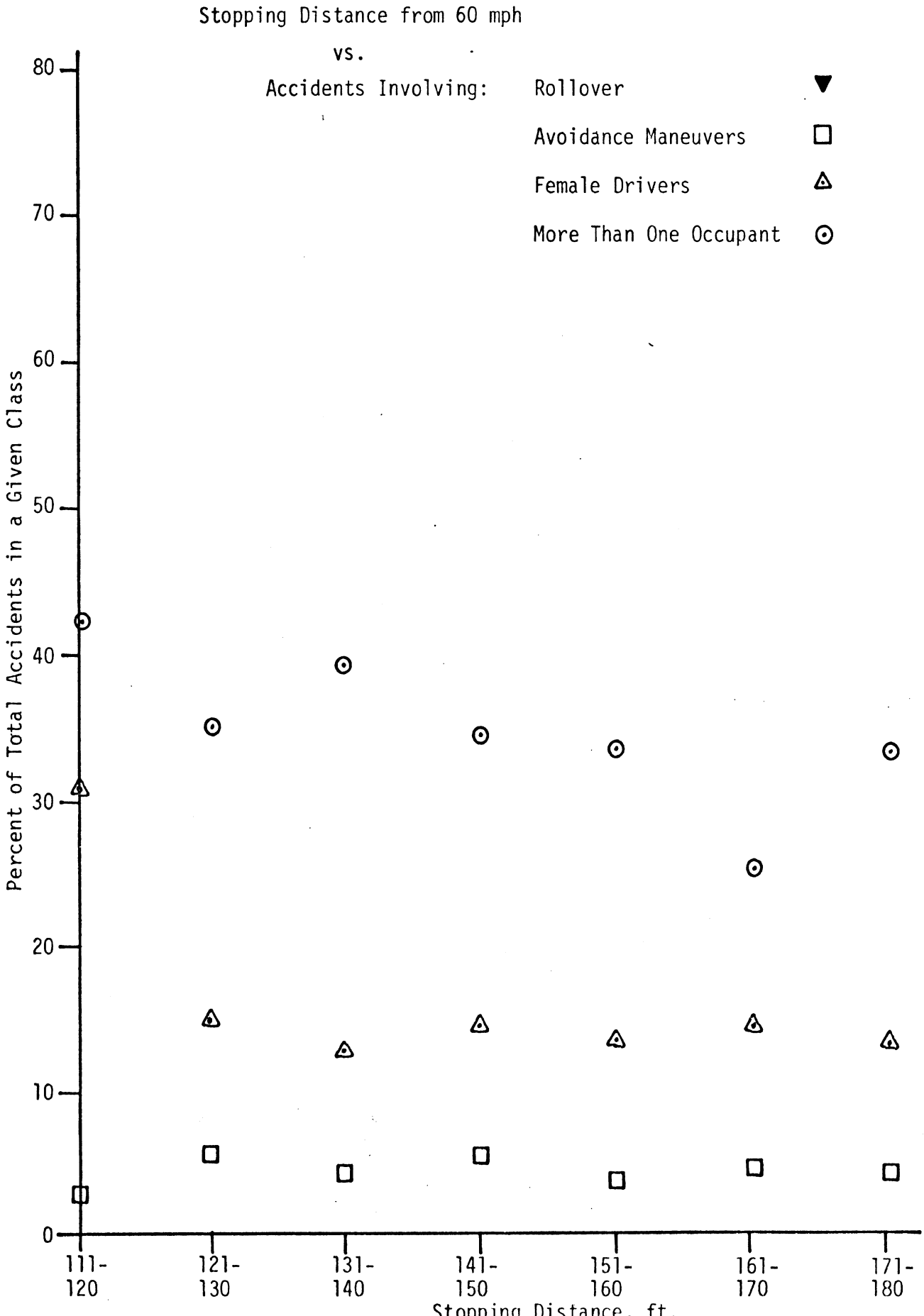

Stopping Distance from 60 mph
vs.
Accidents Involving:
Rollover
Avoidance Maneuvers
Female Drivers
More Than One Occupant
Percent of Total Accidents in a Given Class
0
10
20
30
40
50
60
70
80
111-120
121-130
131-140
141-150
151-160
161-170
171-180
Stopping Distance, ft.

Figure E.58