VALIDATION OF THE "INNOCENT VICTIM" CONCEPT

by

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INTRODUCTION

Comparisons of the relative safety of different classes of vehicles has always been limited by the absence of a reliable measure of "risk" or "exposure" of different classes of vehicles or drivers. Research in this area has been conducted since the 1960's by such analysts as Thorpe, Haight, Waller, Carlson and Cerrelli (2,3,4,5,6), under the general title of "induced" exposure techniques. In 1982, the Transportation Research Center of the U.S. Department of Transportation conducted a review of these methods and concluded:

"The assymetric model[(a)] would combine the best features of the Koonstra model[(b)] with the extra information made use of by the quasi-induced exposure models. This could end up being the best type of induced model when the information for its implementation is available."

The review of assymetric models was not included in the Transportation System Center document, as responsibility data were not available. Thus, while the advantages of the innocent victim concept is recognized, the potential difficulty in validating these models has restricted their use.

A method for using the Michigan Department of Transportation files to estimate the exposure of classes of vehicles based on their relative frequency of involvement in multi-vehicle accidents was developed by Koji Kuroda, et al. at Michigan State University (1). This "induced exposure" measure is based on the assumption that the exposure of any class of vehicles is directly proportional to the number of "vehicle 2" or "innocent victim" involvements in multi-car accidents. The application of this method

(a) Assymetric means the involvement rate for the "guilty" and "innocent" parties are not assumed to be equal.
(b) The Koonstra model is a symetric model where exposure is based on total accident involvement.

of defining exposure is critically dependent on data reliability. One of the most critical pieces of information on the accident record, as far a this method is concerned, is the vehicle identification number (VIN). The VIN is run through a program called VNDCTR which decodes the vehicle characteristics (weight, horsepower, wheel base, etc.) for each of the vehicles involved in an accident. In the previous study by Kuroda (1) it was noted that a number of the vehicles involved in accidents are not decoded through the VNDCTR program due to 1) mistakes in the recording of the VIN made by the reporting officer, 2) mistakes in keying in the computer data entry, or 3) the vehicle codes not existing in VNDCTR. If the errors which cause the VIN's to not decode are not randomly distributed over all vehicle types, then the proposed exposure measure will be biased.

Another possible source of error in this exposure measure is the investigating officers ability to accurately identify vehicle 1 and vehicle 2. These two possible sources of error were investigated in this study along with an assessment of the method using a case study.

The specific objectives of this study are to determine the errors which cause VIN's to not decode, to determine if the incidence of non-decoding is a biased event, to determine the accuracy with which vehicle 1 and vehicle 2 are identified, and to demonstrate the Kuroda vehicle exposure measures in a case study.

NUMBER OF NON-DECODES

The initial work done on the innocent victim concept indicated the rate of non-decodes to be between 25% and 30%. This rate was based on an analysis of single vehicle pasenger car accidents and multiple vehicle passenger car-passenger car accidents on the State Trunkline highway network in 1982. The same accident types for the two year period, 1982 and 1983, was adopted for use in this study. In addition, the 1984 accident data was analyzed to determine if the percentage of non-decodes was changing with time.

Two separate accident files were created; the first file contains all relevant accidents on the trunkline system; the second file includes geometric and roadside development information along with the accident records. A total of 131,156 accidents make up the first file and 97,280 accidents make up the second file. Some 33,876 of the accidents from the first file were lost due to the inavailability of geometric information for these accidents. The second file contains information important to an evaluation of potential bias from the non-decodes so it is the primary file used in this analysis.

To avoid bias, the probability of a vehicle not decoding must be equal for all vehicles involved in an accident. Single vehicle accidents account for 27,933 of the total accidents and there were 7400 non-decodes among these accidents. Multiple vehicles account for 69,347 of the total accidents on file two with 28,469 accidents having at least one vehicle not decoding.

For multiple vehicle accidents the non-decode rate for vehicle one (only) is 15.5 percent and the rate for vehicle two (only) is 13.7 percent. If these are independent occurrances, the incidence of both vehicles not decoding in an accident would be equal to the product of the vehicle one and vehicle two non-decode rate, or about 2 percent. The actual rate for both vehicles not decoding is 11.8 percent, indicating that the probability of vehicle 2 not decoding is not independent of the probability of vehicle 1 not decoding. The total percentage of accidents with at least one decode error for multiple vehicle accidents 41.5 percent. One possible explanation for both vehicles not decoding at a higher rate than expected is that there is a significant number of gross errors in the recording of the VIN (such as coding the registration number in the space for the VIN number), and when this error is made for one vehicle, the same error is made for both vehicles. Single vehicle accidents exhibited a non-decode rate of 26.5 percent, which is higher than that for either vehicle (alone) in a multiple car accident, but could represent a gross error rate of 11.8 percent and a coding error rate of 13.7 to 15.5 percent found in multiple vehicle accidents.

A possible explanation for the high rate of non-decodes is the fact that the VIN information has only been collected since 1980, and the data has not been extensively used in accident analysis. It was postulated that these percentages would be reduced as the reporting officers became more accustomed to the procedure and were notified of the errors being made. Accidents for the Trunkline system in 1984 were examined and compared to the 1982-1983 data (file 1 was used in the analysis). Tables 1 and 2 show the number of single and multiple vehicle accidents, the number of non-decodes and the percentage of non-decodes by Michigan Department of Transportation district for 1982-83 and 1984. While no changes were made in the recording procedure between 1982 and 1984 the overall percentage of non-decodes dropped from 26.5 to 17.1 percent for single vehicle accidents and from 41.5 to 34.1 percent for multiple vehicle accidents.

The statewide percentages for each vehicle for 1982-1983 and for 1984 are shown in Table 3. Because there were no procedural changes made in the recording process, the reduction in the percentage of non-decodes can probably be attributed to the learning curve for a new procedure. The largest reduction occurred in the category where both vehicles failed to decode -

Table 1. Percentage of single vehicle accidents that did not decode by Michigan Department of Transportation District. (2)

SINGLE VEHICLE ACCIDENTS

1982-1983

DISTRICT	TOTAL ACCIDENTS	NON-DECODES	% OF DISTRICT
1	2245	449	20.0
2	1230	433	35.0
3	3097	658	21.0
4	2863	549	19.0
5	6089	1293	21.0
6	5887	1588	27.0
7	5576	1680	30.0
8	6422	1425	22.0
9	9778	3077	31.5
TOTAL	43246	11152	25.8

SINGLE VEHICLE ACCIDENTS

1984

DISTRICT	TOTAL ACCIDENTS	NON-DECODES	% OF DISTRICT
1	1383	217	15.7
2	740	172	23.0
3	1905	319	16.7
4	1745	283	16.0
5	3347	558	16.7
6	3407	522	15.3
7	3168	586	18.5
8	3488	568	16.3
9	5795	1038	17.9
TOTAL	24998	4263	17.1

(2) See Figure 1 for district boundaries.

Table 2. Percentage of multiple vehicle accidents with at least one vehicle not decoding by Michigan Department of Transportation District.

MULTIPLE VEHICLE ACCIDENTS

1982-1983

DISTRICT	TOTAL ACCIDENTS	NON-DECODES	% OF DISTRICT
1	1844	755	41.0
2	735	378	51.4
3	2614	1077	41.2
4	2385	658	27.6
5	10406	3827	36.8
6	10125	3911	38.6
7	7007	3251	46.4
8	11867	4089	34.5
9	40927	18521	45.3
TOTAL	87910	36467	41.5

MULTIPLE VEHICLE ACCIDENTS

1984

DISTRICT	TOTAL ACCIDENTS	NON-DECODES	% OF DISTRICT
1	935	302	32.3
2	353	151	42.8
3	1368	496	36.3
4	915	279	30.5
5	5615	1730	30.8
6	5938	1850	32.1
7	3948	1404	35.6
8	6978	2220	31.8
9	25775	9249	35.9
TOTAL	51825	17681	34.1

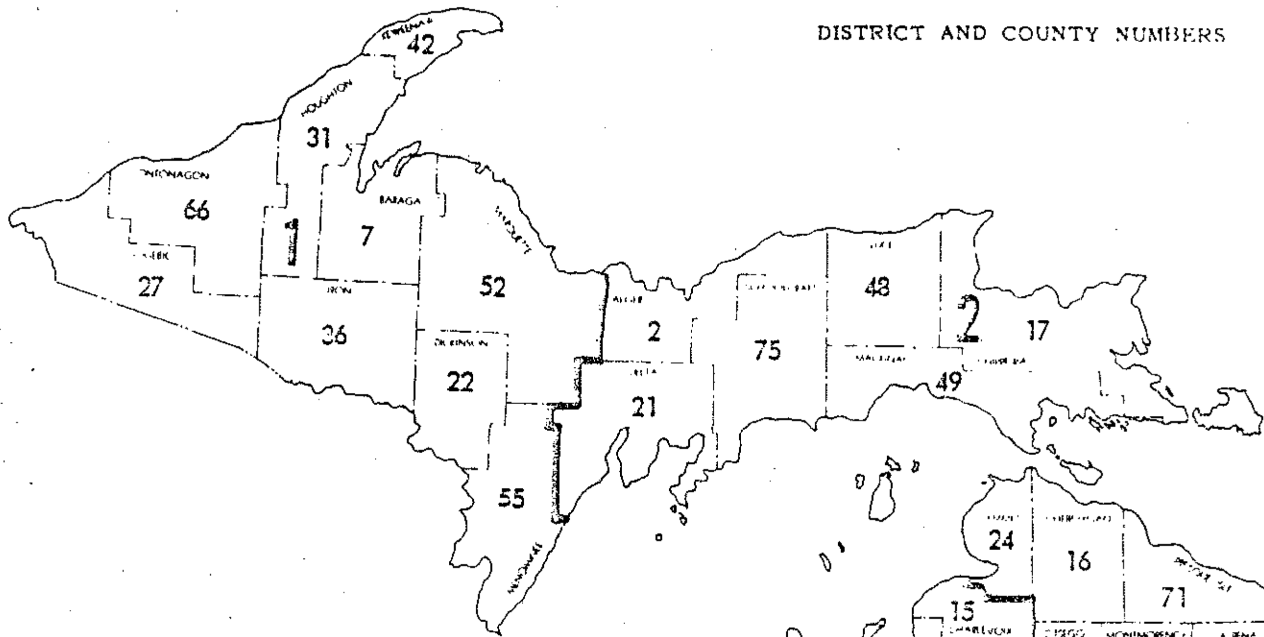
Table 3. Improvement in decoding accidents from 1982-83 to 1984.

Vehicle Number	% Non-decodes	
	1982-1983	1984
Single Vehicle	26.5	17.1
Vehicle 1	15.5	16.1
Vehicle 2	13.7	13.3
Vehicles 1 & 2	11.8	4.7
Multiple Vehicle Total	41.5	34.1

FIGURE 1

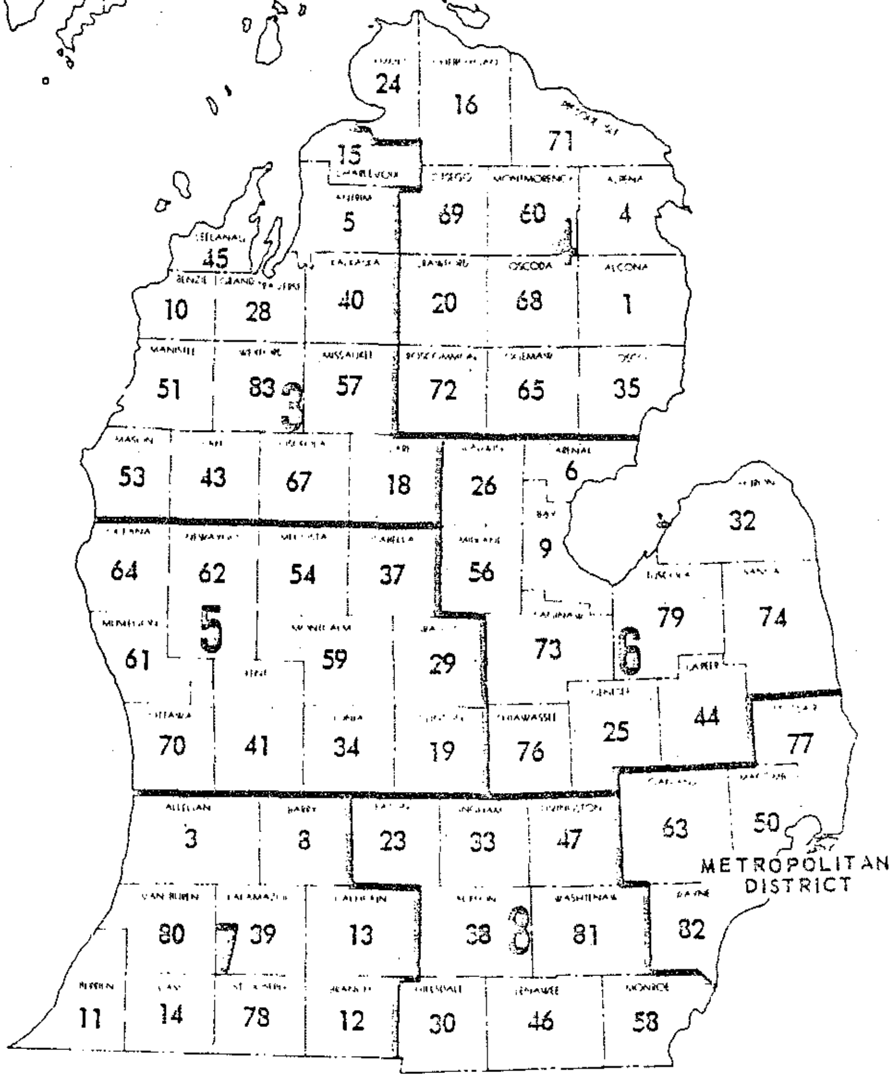
MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION

DISTRICT AND COUNTY NUMBERS



COUNTIES

	DIST.		DIST.
1. ALCONA	4	43. LAKE	3
2. ALGER	2	44. LAPEER	6
3. ALLEGAN	7	45. LEELANAU	3
4. ALPENA	4	46. LENAWEE	8
5. ANTRIM	3	47. LIVINGSTON	8
6 ARENAC	6	48. LUCE	2
7. BARAGA	1	49. MACKINAC	2
8. BARRY	7	50. MACOMB	MET.
9. BAY	6	51. MANISTEE	3
10. BENZIE	3	52. MARQUETTE	1
11. BERRIEN	7	53. MASON	3
12. BRANCH	7	54. MECOSTA	5
13. CALHOUN	7	55. MENOMINEE	1
14. CASS	7	56. MIDLAND	6
15. CHARLEVOIX	3	57. MISSAUKEE	3
16. CHEBOYGAN	4	58. MONROE	8
17. CHIPPEWA	2	59. MONTCALM	5
18. CLARE	3	60. MONTMORENCY	4
19. CLINTON	5	61. MUSKEGON	5
20. CRAWFORD	4	62. NEWAYGO	5
21. DELTA	2	63. OAKLAND	MET.
22. DICKINSON	1	64. OCEANA	5
23. EATON	8	65. OGEMAW	4
24. EMMET	4	66. ONTONAGON	1
25. GENESEE	6	67. OSCEOLA	3
26. GLADWIN	6	68. OSCODA	4
27. GOGEBIC	1	69. OTSEGO	4
28. GD.TRAVERSE	3	70. OTTAWA	5
29. GRATIOT	5	71. PRESQUE ISLE	4
30. HILLSDALE	8	72. ROSCOMMON	4
31. HOUGHTON	1	73. SAGINAW	6
32. HURON	6	74. SANILAC	6
33. INGHAM	8	75. SCHOOLCRAFT	2
34. IONIA	5	76. SHIAWASSEE	6
35. IOSCO	4	77. ST. CLAIR	MET.
36. IRON	1	78. ST. JOSEPH	7
37. ISABELLA	5	79. TUSCOLA	6
38. JACKSON	8	80. VAN BUREN	7
39. KALAMAZOO	7	81. WASHTENAW	8
40. KALKASKA	3	82. WAYNE	MET.
41. KENT	5	83. WEXFORD	3
42. KEWEENAW	1		



which is the category most likely to be affected by errors in understanding the procedure.

In the period 1982-1983 the chance of a vehicle involved in a single vehicle accident not decoding was not equal to that of either vehicle involved in a multiple vehicle accident. In 1984 the chances of a vehicle involved in any accident (single or multiple vehicle) not decoding was roughly the same. This phenomenon should occur as those involved in the recording of VIN's become more familiar with the procedure, and the gross error rate is reduced.

DISTRIBUTION OF NON-DECODES

The total accident population (file 2) was split into single vehicle and multiple vehicle accidents by Michigan Department of Transportation district. Each of these files was then divided into three files according to development (rural, urban, and fringe). The total and number of non-decoded accidents by district and development type for single and multiple vehicle accidents are shown in Tables 4 and 5 respectively. The total percentage not decoding by district is also shown.

This division was made to gain some insight into potential differences in non-decode rates for various reporting agencies. Since the reporting agency (State police, county sheriff or city police) are not coded on the 182 character MDOT files, the division into rural, fringe and urban was used as a surrogate measure of the reporting agency. We recognize that this is not a completely satisfactory surrogate, but believe some interesting observations can be made from this division, and perhaps some targeted effort could be developed to improve data accuracy.

Table 4. Distribution of non-decoded single vehicle accidents by development and district.

DISTRICT	RURAL			FRINGE			URBAN			TOTALS		
	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)
1	1710	332	19.4	404	89	22.0	139	28	20.1	2253	449	19.9
2	924	336	36.4	165	56	33.9	42	24	57.1	1131	434	38.7
3	2317	478	20.6	382	105	27.5	131	27	20.6	2830	610	21.5
4	1720	313	18.2	346	72	20.8	179	38	21.2	2245	423	18.8
5	2470	466	18.9	370	86	23.2	702	167	23.8	3542	719	20.3
6	2760	752	22.2	1323	378	28.6	176	43	24.4	4259	1173	27.5
7	2500	841	33.6	1030	354	34.4	118	46	39.0	3648	1241	34.1
8	2432	492	20.2	1084	260	24.0	184	50	27.1	3700	802	21.6
9	634	404	63.7	1155	264	22.9	2536	919	36.2	4325	1587	36.7
TOTAL	17467	4414	25.3	6259	1664	26.6	4207	1342	31.4	27933	7438	26.6

Table 5. Distribution of non-decoded multiple vehicle accidents by development and district.

DISTRICT	RURAL			FRINGE			URBAN			TOTALS		
	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)
1	409	182	44.5	973	400	41.1	454	173	38.1	1836	755	41.1
2	175	107	61.1	391	176	45.0	130	74	56.9	696	357	51.3
3	900	395	43.9	1446	591	40.9	167	59	35.3	2513	1045	41.6
4	326	135	41.4	557	212	38.1	689	274	39.8	1572	621	39.5
5	2049	768	37.5	1968	729	37.0	4435	1583	35.7	8452	3080	36.4
6	1387	561	40.4	6485	2510	38.7	903	369	40.9	8775	3440	39.2
7	1510	691	45.8	3998	1882	47.1	756	345	45.6	6264	2918	46.6
8	1708	565	33.1	7399	2567	34.7	1309	448	34.2	10416	3580	34.3
9	1213	695	57.3	9813	3642	37.1	17797	8286	46.6	28823	12623	43.8
TOTAL	9677	4099	42.4	33030	12709	38.5	26640	11611	43.5	69347	28419	41.0

Observations from Tables 4 and 5 include:

- A higher percentage of both single vehicle and multiple vehicle accidents fail to decode in urban areas than in either fringe areas or rural areas. This may be due to the agency completing the accident form or the distribution of vehicles by age (age of vehicle is shown to present a bias later in this report).

- Department of Transportation District Number 2 has the highest rate of non-decodes for both single and multiple vehicle accidents.

- Accidents occurring in rural areas in Department of Transportation District 9 have a much higher non-decode rate than those occurring in urban or fringe areas.
- Using rural, fringe, and urban developments as surrogate measures for the State Police, Sheriff's Department, and City Police respectively, State Police have the lowest percentage of non-decodes (31.4%) followed by the Sheriff Department's (36.6%) and the City Police (42.0%).

These six files were then each divided into two files, injury accidents and P.D.O.'s. Table 6 shows the accidents by development and injury type for single and multiple vehicle accidents.

It was postulated that the investigating officer might take more care in recording the information for an injury accident than for a non-injury accident. However, only small differences were found in the incidence of non-decodes for rural and fringe accidents. In urban areas there is a tendency toward greater accuracy in injury accidents, which might support the hypothesis that greater care is excercised in coding injury accidents than in coding non-injury accidents. However, this may also be due to the practice of having a police officer complete the UD-10 for all injury accidents while depending on the persons involved to supply data for non-injury accidents, particularly in the City of Detroit.

DISTRIBUTION OF NON-DECODES WITHIN THE VEHICLE FLEET

Knowledge of the distribution of non-decodes within the fleet of passenger cars is essential to the exposure measure proposed by Kuroda et al.

Table 6. Distribution of non-decoded accidents by development and accident severity.

MULTIPLE VEHICLE ACCIDENTS

ACCIDENT TYPE	RURAL			FRINGE			URBAN		
	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)
Injury	2115	862	40.8	4696	1722	36.7	3511	1337	38.1
No Injury	7562	3237	42.8	28334	10987	38.8	23129	10274	44.4
TOTAL	9677	4099	42.4	33030	12709	38.5	26640	11611	43.6

SINGLE VEHICLE ACCIDENTS

ACCIDENT TYPE	RURAL			FRINGE			URBAN		
	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)	Total	Non-Decodes	(%)
Injury	2738	780	28.5	1428	355	24.9	1055	284	26.9
No Injury	14729	3634	24.7	4831	1309	27.1	3152	1058	33.6
TOTAL	17467	4414	25.2	6259	1644	26.3	4207	1342	31.9

(1). If any vehicle weight class is over- (or under-) represented in the non-decodes, this will bias the exposure measure for that class of vehicles.

Table 7 shows the distribution of vehicles, by manufacturer, for vehicles involved in single and multiple vehicle accidents. While there are no major differences in the decode percentages, Ford vehicles are slightly lower in non-decodes while all other manufacturers are somewhat higher.

An attempt was made to determine if this phenomenon could be explained by the VIN code used by the various manufacturers. It appears that this phenomenon is related to the fact that Ford used shorter VIN codes (approximately 12 digits) for their pre-1980 vehicles than did the other manufacturers. The short VIN's reduce the number of opportunities for a random error and result in a lower non-decode rate. All manufacturers now use 17 character codes, so each manufacturer should have the same chance for error.

The distribution of non-decodes by vehicle weight was determined using the accident files, the Secretary of State license plate files, and the VNDCTR 84 program. Two-hundred random copies of accident reports for non-decodes were pulled from the accident files and the license plate numbers for the non-decodes were recovered. These plate numbers were then run through the license plate file. The VIN number for 136 vehicles whose

Table 7. Distribution of vehicles by manufacturer for passenger cars involved in accidents.

	GM	FORD	CHRYSLER	OTHER
TOT	112347	49361	30088	25798
%	51.6	22.7	13.8	11.9
ND	16868	5711	4956	4217
%	53.1	18.0	15.6	13.3

plates and vehicles could be matched to those on the accident reports were run through the VNDCTR program. The vehicle weights for the previously non-decoded vehicles involved in accidents were recovered and compared to the overall fleet percentage by weight class. This comparison is shown in Table 8. The sample size for many of the weight classes was too small for statistical testing, but there does not appear to be a bias in the vehicle weight distributions.

The distribution of non-decodes by year was checked to see if age of vehicle was a factor in determining if a vehicle would be decoded. Table 9 shows the percentage of vehicles within the fleet for pre-1975, 1975-1979, and 1980-1984 vehicles. The same years are used to group 161 non-decodes recovered from the Secretary of State license plate files. Older vehicles decode less frequently than newer vehicles. A possible explanation is that the VIN codes for older vehicles are not as complete in the VNDCTR program as those for newer vehicles.

These recorded VIN numbers for those vehicles recovered from the Secretary of State license plate files were manually compared to the correct VIN's recovered from the plate files. Gross errors (36%) and general carelessness in the recording of the VIN's (64%) are responsible for the non-decodes. Officers leaving the VIN code blank or recording the vehicle registration number for the VIN code were two of the obvious errors. In other instances, omissions (leaving out letters and/or numbers) and illegible handwriting lead to misinterpretation of the recorded numbers. These errors, however, are not concentrated in any specific class, weight, or make of vehicle, and thus should have no biasing effect on the Kuroda exposure method.

Table 8. Vehicle weight distribution for all vehicles and for non-decoded vehicles.

Weight	Fleet	(%)	Non-Decodes	(%)
1500-2499	25851	(21.1)	29	(21.3)
2500-2999	22000	(17.9)	25	(18.4)
3000-3499	28899	(23.6)	29	(21.3)
3500-3999	24729	(20.2)	33	(24.3)
Over 4000	21213	(17.3)	20	(14.7)
TOTAL	122692		136	

Table 9. Distribution of Non-decodes by year of vehicle manufacture.

Years	Non-Decodes	(%)	Fleet	(%)
Pre 1975	32	(19.9)	641427	(14.8)
1975-1979	65	(40.3)	1794216	(41.4)
1980-1984	64	(39.8)	1894540	(43.8)
TOTAL	161	(100)	4330183	(100)

Errors in Coding Vehicle 1 and Vehicle 2

A sample of the hard copies of file 2 accident reports were examined to determine the accuracy of the vehicle one-vehicle two designations recorded on the accident report form (UD-10). A total of 400 reports were reviewed and 64 (16%) were found to have incorrect vehicle designations. The most common accident type in which a coding error was made was the rear-end accident where the vehicle being struck was coded as vehicle one. Another common error is coding the victim of an intersection collision as vehicle 1 on the UD-10. Table 10 lists the accident types which are most commonly miscoded.

Table 10. Accident types in which the Vehicle 1-Vehicle 2 designation is incorrect.

	Area Type		
Accident Type	Rural	Fringe	Urban
Rear End	8	9	8
Intersection	10	5	3
Driveway	4	2	1
Passing	4	4	0
Other	2	4	0

Accidents reported by the driver rather than being investigated by a police officer constitute a significant number of accidents in which there is an error in the vehicle designation. Often, the individual reporting the accident is recorded first on the UD-10, thus being designated as Vehicle 1, regardless of the driver at fault. Five of the 25 rear-end accidents containing the wrong designation were reported by individuals rather than a police agency.

Since all of these sources of error in designating vehicle 1 and vehicle 2 are independent of the characteristics of the vehicle or the driver, there is no reason to suspect that these errors introduce a bias into the innocent victim exposure method. They do, however, increase the standard error of the estimated exposure. This is of particular concern when the stratification of data leads to small samples in any single category.

Demonstration of an Analysis Using the Kuroda Exposure Technique

Having determined that there is no bias in the VIN decoded data relative to vehicle size, the data files were used to conduct a demonstration of the Kuroda exposure method. The selected demonstration is a comparison of accident frequencies for front wheel drive versus rear wheel drive automobiles. This example was chosen because it has been postulated that different types of accidents would occur when the roads are wet or icy because of the different response of these two vehicle types to skidding.

Since it had been previously determined that vehicle weight was a significant factor in determining accident frequency (1), the first analysis was conducted by vehicle weight class. File 2 was divided into seven weight classes as shown in Table 11, and these categories were then separated into front wheel drive and rear wheel drive vehicles for model years 1980 through 1985. The exposure measure is the percentage of vehicle two (the innocent victim) appearing in each cell in the first two columns of Table 11. The sample size is greater than 150 for all cells except front wheel drive vehicles weighing more than 4000 pounds.

The number of vehicles in each category involved in single vehicle accidents and the number of times a vehicle in each category is involved as vehicle one in automobile-automobile accidents is recorded in the remaining columns of Table 11.

Table 11. Distribution by weight for rear and front wheel drive vehicles.

Vehicle Weight	EXPOSURE				VEHICLE ONE				SINGLE VEHICLE			
	Rear Drive	(%)	Front Drive	(%)	Rear Drive	(%)	Front Drive	(%)	Rear Drive	(%)	Front Drive	(%)
1500-1999	2768	(4.2)	1106	(1.7)	1920	(3.8)	636	(1.3)	882	(4.3)	369	(1.8)
2000-2499	5370	(8.2)	5396	(8.2)	3927	(7.8)	3387	(5.7)	1732	(8.4)	1660	(8.1)
2500-2999	9631	(14.6)	2336	(3.5)	7394	(14.6)	1515	(3.0)	3168	(15.5)	563	(2.8)
3000-3499	15294	(23.1)	155	(0.2)	11792	(23.3)	116	(0.2)	4851	(23.6)	39	(0.2)
3500-3999	12697	(19.2)	344	(0.5)	10344	(20.5)	230	(0.5)	3838	(18.7)	60	(0.3)
4000-4499	8076	(12.2)	30	(0.1)	6977	(13.8)	22	(0.0)	2504	(12.2)	7	(0.0)
Over 4500	2852	(4.3)	0	(0.0)	2253	(4.5)	0	(0.0)	839	(4.1)	1	(0.0)
TOTALS	56688	(85.8)	9367	(14.2)	44607	(88.3)	5907	(11.7)	17814	(86.8)	2699	(13.2)

Figure 2 shows the ratio of the actual representation of each cell over the expected representation of that cell for single vehicle accidents (A/E ratio). Overall, there is no apparent difference in the ratio with regard to the drive wheels. Rear wheel drive automobiles have 85.8 percent of the exposure, and are involved in 86.8 percent of the single vehicle accidents. As in the previous study, rear wheel drive automobiles are slightly over-represented in the light weight vehicle categories.

There are two anomolies in the front wheel drive automobile. Vehicles weighing between 2500 and 2999 pounds are significantly under-represented in single vehicle accidents, as are those vehicles weighing between 3500 and 3999 pounds. This last data point may be the result of the small sample size, but this is not true of the first data point.

Figure 3 shows the comparable data for the vehicle 1 A/E ratio by weight. There is the expected overrepresentation of larger vehicles in multiple vehicle accidents that was found in the Kuroda study (1). However, it is interesting to note that front wheel drive automobiles are consistently under-represented in accidents across all weight categories. The trend toward increased involvement with increased weight is present, but the number of accidents is consistently lower than the number to be expected based on the innocent victim concept. Overall, the A/E ratio is 1.03 for rear wheel drive vehicles and 0.82 for front wheel drive vehicles.

In an attempt to test the hypothesis that front wheel drive automobiles are more difficult to control on ice, accidents involving both rear wheel and front wheel drive automobiles were divided into three categories of pavement condition (dry, wet and ice/snow) at the time of the accident as shown in Table 12. To gain additional insight into the effect of pavement condition, the data were further separated into accidents occurring on

Table 12. Distribution by surface condition for accidents involving rear and front wheel drive vehicles.

Vehicle	Axle	FREE ACCESS						FREEWAY					
		Dry	(%)	Wet	(%)	Icy	(%)	Dry	(%)	Wet	(%)	Icy	(%)
Multiple Vehicle	Rear	37711	(59.7)	16591	(26.3)	8862	(14.0)	8638	(52.3)	4497	(27.2)	3395	(20.5)
	Front	3763	(63.1)	1539	(35.8)	658	(11.0)	655	(55.7)	304	(25.9)	216	(18.4)
Single Vehicle	Rear	15796	(63.0)	4528	(18.1)	4734	(18.9)	7007	(51.8)	2472	(18.3)	4059	(30.0)
	Front	1805	(65.9)	486	(17.7)	446	(16.3)	1043	(60.8)	311	(18.1)	362	(21.1)
Exposure	Rear	47357	(60.0)	20164	(25.6)	11301	(14.3)	11534	(54.1)	5545	(26.0)	4226	(19.8)
	Front	5883	(62.1)	2519	(26.6)	1077	(11.4)	1846	(59.5)	796	(25.6)	462	(14.9)

Table 13. Actual/expected ratio for rear and front wheel drive vehicles.

Vehicle	Axle	FREE ACCESS			FREEWAY		
		Dry	Wet	Ice/ Snow	Dry	Wet	Ice/ Snow
Multiple Vehicle	Rear	1.0	1.03	.98	.97	1.05	1.04
	Front	1.02	.97	.96	.94	1.01	1.23
Single Vehicle	Rear	1.05	.71	1.32	1.06	.67	1.43
	Front	.96	.70	1.51	1.02	.71	1.42

Figure 2. Single Vehicle/Exposure for Rear and Front Wheel Drive Automobiles

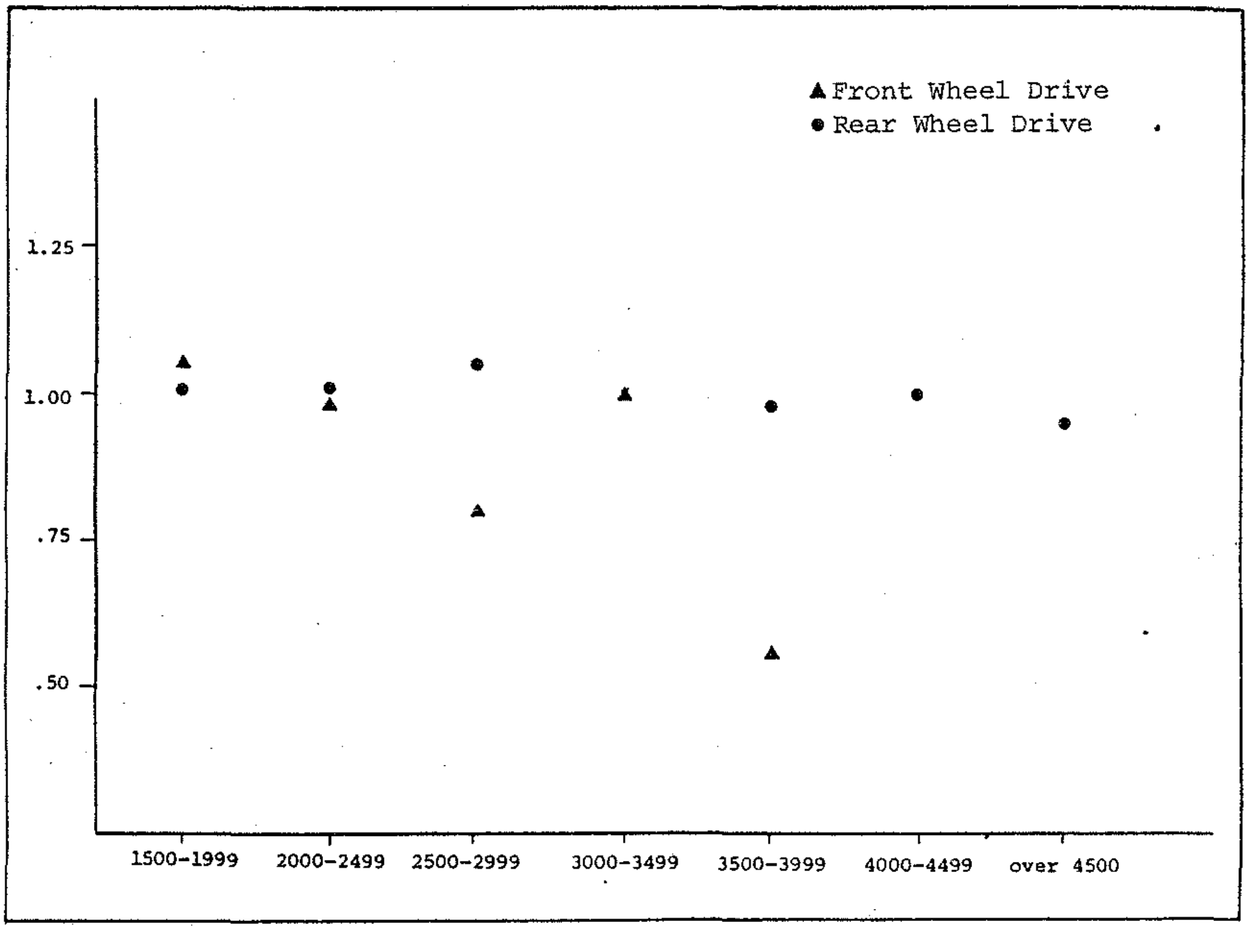
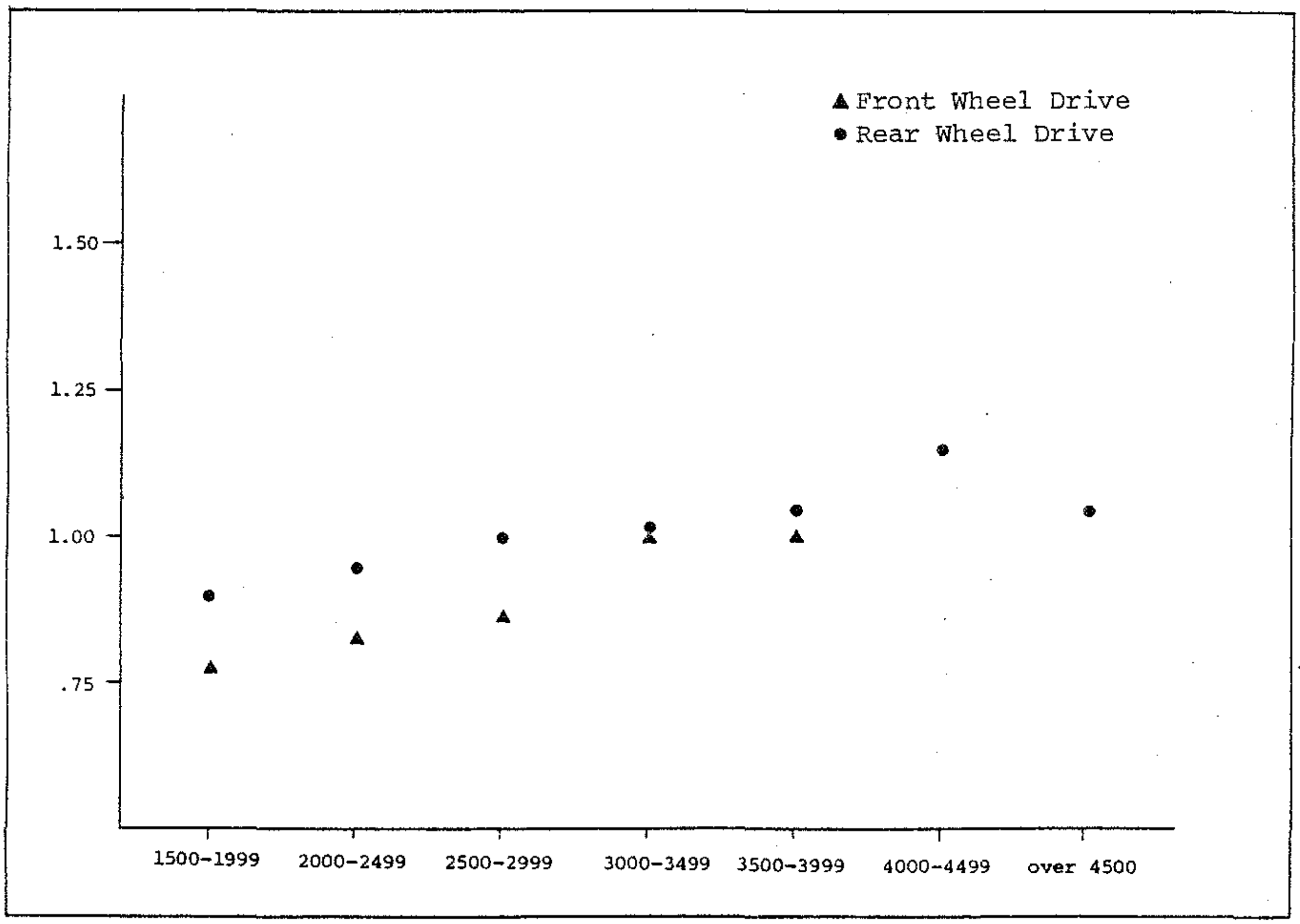


Figure 3. Vehicle One/Exposure for Rear and Front Wheel Drive Automobiles



freeways and those occurring on other state trunkline highways. Table 13 presents the A/E ratio for each of these categories.

The A/E ratio for all multiple vehicle categories is close to 1.0 except for front wheel drive vehicles on ice/snow covered freeways which tend to be overrepresented, with an A/E ratio of 1.23. It is clear (and expected) that there is an overrepresentation of single vehicle accidents on both icy roads and freeways. On freeways, the A/E ratio is 1.43 and 1.42 for rear and front wheel drive vehicles respectively, and on other roads, these respective ratios are 1.32 and 1.51. The fact that there is a higher A/E ratio for front wheel drive vehicles on state trunkline roads than on freeways may be related to the more severe geometry encountered on these roads.

Statistical tests using the Chi-Square test for comparing percentages (8) were conducted to determine whether there were significant (.95 level of confidence) differences in the accident characteristics of front wheel drive and rear wheel drive automobiles. The following differences were noted:

a) On non-freeway state trunkline highways, the probability of a front wheel drive automobile being a vehicle 1 given that it is involved in an accident is significantly less than that same probability for rear wheel drive automobiles (.478 and .528 respectively).

b) On freeways, the probability of a front wheel drive vehicle being a vehicle 1 given that it is involved in an accident is significantly less than that same probability for rear wheel drive automobiles (.482 and .585 respectively).

c) On non-freeway state trunkline highways, the probability of a front wheel drive automobile being coded as a vehicle one on icy roads as opposed to other road conditions is significantly lower than that same probability for rear wheel drive automobiles (.127 and .182 respectively).

d) On freeways, the probability of a front wheel drive automobile being coded as a vehicle one on an icy road as opposed to other road conditions is significantly lower than that same probability for rear wheel drive automobiles (.200 and .248 respectively).

e) Using a Chi-square analysis, on freeways, the percentage of front wheel drive automobile accidents occurring on icy roads was found to be significantly lower than the percentage of rear wheel drive automobile accidents occurring on icy roads (.25 to .33). On non-freeway state trunk-lines, the respective percentages are .15 and .18. This difference is not significant at the .95 level of confidence.

CONCLUSIONS AND RECOMMENDATIONS

Previous studies conducted at Michigan State University using the induced exposure method developed by Kuroda analyzed the distribution of accidents for various categories of vehicle weight, driver characteristics and urban versus rural locations. The results of these studies and the extended use of this technique to estimate the exposure of any sub-group of vehicles is dependent on the validity of the data. Data items such as age and sex of the driver, urban versus rural locations, type of accident, time of day and other characteristics of the roadway and driver are reliable, particularly when the analysis is based on large samples, such as those available in the Michigan Department of Transportation files.

However, vehicle characteristics are not recorded at the scene of the accidents, but are derived from the VIN number recorded by the investigating officer. Because the VIN is a multiple digit numeric and alphabetic code, there is a much greater possibility of error in obtaining correct vehicle characteristics than in obtaining correct driver and roadway data. In the previous study, nearly thirty percent of the VIN data failed to decode. One of the purposes of this study was to study the distribution of the vehicles which fell into this category.

For 1982 and 1983 accident reports, the rate at which either no data or the wrong data are recorded in the VIN field is about 12 percent. In addition, there is about a 15-16 percent probability that an error is made in recording or interpreting the VIN. This leads to a 27 percent non-decode rate for single vehicle accidents (12% + 15%) and a 40 percent non-decode rate for two car accidents (12% + 15% + 15% - 2%). In the 1984 accident file, this non-decode rate has been reduced to 17 percent for single vehicle accidents and to 35 percent for two car accidents. These numbers represent a reduction in the rate at which either no data or the incorrect data are recorded in the VIN field from 12 percent to 2 percent, with the recording (or interpreting) error of 15-16 percent.

Efforts to instruct officers in the correct procedures for recording the VIN data, and to impress upon them the importance of carefully and legibly recording the data should be continued.

There is a large deviation in the percent of accidents failing to decode by Michigan Department of Transportation district and by rural versus urban locations within a given district. Thus, training programs can be targeted to accomplish the training most efficiently.

Vehicle manufacturer and vehicle weight do not appear to be significant variables in determining whether a VIN will decode. However, the age of the vehicle is a significant variable, with vehicles manufactured prior to 1975 being less likely to decode. This may have a significant effect on the use of the Kuroda exposure measure if these vehicles are concentrated in any sub-group identified for analysis (such as young drivers or male drivers).

With the possible exception of vehicle age, there does not appear to be any vehicle characteristic that would bias the results of the Kuroda exposure measure by under- (or over-) estimating the exposure of any one analysis category. However, non-decode rates of 25-42 percent will result in less reliable estimates of exposure than desirable. Until the rate of non-decodes is significantly reduced, analyses using this measure should be based on large data bases, such as the Michigan Department of Transportation accident files.

The case study of accidents involving front wheel versus rear wheel drive automobiles found that their overall single vehicle accident rates are similar. Rear wheel drive automobiles have 85.8 percent of the exposure and are involved in 86.8 percent of the single vehicle accidents. However, the frequency of accidents in which front wheel drive cars are classified as vehicle one is lower than the expected rate for all vehicle weight classes.

The only evidence of over-representation for front wheel drive automobiles was found on snow covered or icy roads. Under these conditions, both front wheel drive automobiles and rear wheel drive automobiles are over-represented, with the ratio being higher on freeways for rear wheel drive automobiles (1.43 vs. 1.32) and higher on state trunkline roads for front wheel drive automobiles (1.51 vs. 1.42).

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