

**SUMMARY OF ROLLOVER STUDIES,
IIHS DEMONSTRATION PROJECT: 1980-84**

THE HSRI STUDY

"On-Road Crash Experience of Utility Vehicles," Snyder et al., was published in February, 1980, by the Highway Safety Research Institute of the University of Michigan. It was funded in part by a grant from the Insurance Institute for Highway Safety.

The stated purpose of the study was to "analyze the available on-road collision experience" involving utility vehicles "designed for on/off-road use," so as "to determine the nature, extent and seriousness of any problems unique to this category of vehicle, and to provide a basis for further investigation and/or safety recommendation."

The study was wide-ranging in its historical depth, breadth of issues considered, and findings. Below are discussed its findings that specifically relate to the CJ.

Case Involvement: Of 111 product liability cases involving utility vehicles reported by the Professional Research and Development Department of the American Trial Lawyers Association during 1967-69, the largest single group -- 23 cases -- was identified as "jeeps." The next largest single group -- 21 cases -- specifically identified CJ-5s. The third largest -- 19 -- identified Ford Broncos.

(In a list of defects alleged in each case for all involved vehicles, "rollover" was nearly three times as often reported -- 45 incidents -- as the next most frequently alleged defects, which were "roll-bar collapse" and "steering mechanism, lost control," each of which accounted for 16 reported incidents.) (On-Road, pp. 26-27.)

Data Analysis: "On-Road" analyzed data from the following primary sources:

State statistical files of eight states; the CPIR file, which represents the results of a non-random compilation of in-depth studies of special-interest crashes sponsored by U.S. government and auto industry funds and the Canadian government; FARS (Fatal Accident Reporting System of the National Highway Traffic Safety Administration); R.L. Polk & Co. registration lists; accident photo analysis of selected cases; and Fatal Accident Case Review data encompassing all fatal accident reports in Arizona and New Mexico for specified products.

"Secondary sources" -- available literature, product liability data, and physical measurement of vehicle parameters such as height and center of gravity -- were also used.

-- Of the 300 cases of injury-producing accidents investigated by the Arizona Department of Public Safety for the year 1978, "Jeeps" -- including AMC, Kaiser and Willys -- accounted for 54 percent of the total.

(On-Road, p. 73, Table 4.4.1-2.)

- Of the 37 fatal accidents (with 42 fatalities) involving utility vehicles in Arizona that year, 27 were analyzed. (The remainder were not relevant to the study.) A disproportionate number of AMC Jeep vehicles -- 16, or 59 percent -- were found in this group. Two Willys Jeeps were also found, bringing the percentage to 67. (On-Road, p. 77, Table 4.4.1-4.)
- Percentage shares of rollover crashes in Michigan and Washington, based on FARS data for 1977, were much higher for "Jeep" vehicles and Ford Broncos than for other utility vehicles for which data were available. "It should be noted here that the 1978 Ford Bronco is larger than the models included in these data. A subsequent analysis (including the larger Bronco) should show the new Bronco performing more like the Blazer size vehicles." (This was later borne out by the HSRC "Further Look" study.) (On-Road, p. 111, Table 4.5.1-3.)

Physical Factor Measurements: Using the formula

$A_y = \frac{T}{2} - h$, where T is the vehicle's track width and h is the height from the ground of its center of gravity, "On-Road" ranked the A_y values (lateral acceleration required to roll, in Gs) of five utility vehicles and compared these to those of seven popular passenger vehicles, including two manufactured by AMC. The lower the A_y value, the higher the likelihood of rollover "as an on-road (tire traction force-induced) phenomenon," all other factors being equal.

The CJ vehicles were shown to have the lowest A_y values -- 1.01 for the CJ-5 and 1.07 for the CJ-7 of the vehicles measured, with the exception of a 1968 Ford Bronco modified so as to raise its center of gravity height. The vehicles with larger "stability envelopes" -- track x wheel base -- "have a greater resistance to rollover than those with a smaller stability envelope." (On-Road, p. 119, Table 4.5.3-1.)

From the results of the physical measurements, "On-Road" reached these conclusions (pp. 120-121):

- "To enhance the roll stability of a utility vehicle, either the track must be made wider or the C.G. lowered, or both. (Merely placing wider tires on the vehicle does not necessarily increase the roll stability.) Any attempt at gaining more ground clearance or riding height of the vehicle is done so at a sacrifice in roll stability."
- "The effect of placing over-diameter tires on a small utility vehicle, for example, would be to decrease the roll resistance to a point where tire forces alone could cause it to overturn if given sufficient lateral acceleration. The lateral acceleration could result from the vehicle going into a skid and rotating such that the side of the vehicle is presented to the line of travel (not an uncommon situation). In such a case, any pavement irregularity or change in the road surface coefficient of friction could become the tripping agent, including

vehicle roll."

-- "It should be noted that in 1977 the Ford Bronco changed in dimension (stability envelope) such that it now approximates the Chevrolet Blazer in size and should be inherently much more stable than its predecessor."

-- "The major conclusion from this analysis is that the utility vehicles with small stability envelopes (JEEP, Land Cruiser, pre-1978 Bronco) are more likely to roll over than vehicles with larger stability envelopes (Blazer, post-1977 Bronco, Ramcharger) given similar C.G. heights. (The Scout II has a stability envelope that would be classified as medium in size.) The small utility vehicles may be overturned only by the side forces generated by the tires in unusual maneuvers whereas the larger utility vehicles generally require some tripping force or obstacle (such as a curb, etc.) before overturning."

Injury Mechanisms: Utility vehicles account for much higher percentages of occupant ejection in single-vehicle crashes than passenger cars; Washington data showed that "total driver ejection. . . is much more likely in a Jeep than in most other models of utility vehicles or passenger cars." (On-Road, pp. 121-122, Table 4.6.1-2.)

Major Conclusions: These included the following involving the CJ (On-Road, pp. 148-149):

- "Based on the height of the center of gravity, utility vehicles as a class are more likely to overturn, and within the utility vehicle class those with a small stability envelope (JEEP, Jeep, pre-1978 Bronco, Scout, Land Cruiser) are more likely to overturn than those with a larger stability envelope (Blazer, Ramcharger, Jimmy, Trail Duster). The JEEP and the Bronco (pre-1978) overturn at least twice as often during a crash as the Blazer. Further, among those vehicles with the smaller stability envelope, the tire side forces may be sufficient to initiate the overturn, whereas utility vehicles with a larger stability envelope probably require an external tripping force (curb, pothole, etc.)." (On-Road, p. 148.)
- "Driver ejection is more often reported among JEEPS than other makes of utility vehicles or passenger cars. Driver ejection is also more often reported among open or canvas top utility vehicles than among rigid top utility vehicles." (On-Road, p. 148.)
- "Traffic death rates and rates of disabling injury are higher in utility vehicles than in passenger cars, whether considering all occupants or just drivers. Considering all occupants, both the death rate and rate of serious injury are about twice as high in utility vehicles. Additionally, both death and injury rates are approximately twice as high in JEEPS as in Blazers."

TABLE 4.4.1-2

INCIDENCE OF ACCIDENTS
BY MODEL: ARIZONA, 1978

Injury Accident	Percent of Total
Jeep*	54
Blazer	18
Bronco	8
Scout	7
Land Cruiser	5
Jimmy	3
Other (Travel-alls, Station Wagons, etc.)	5
Total	100%
Total Number of Crashes	300

*Includes Willys, Kaiser Jeeps, and AMC JEEP

TABLE 4.4.1-4

FREQUENCY OF MODEL INVOLVEMENT
IN 1978 ARIZONA FATAL UTILITY VEHICLE COLLISIONS

Model	Percent of Total*
JEEP, Jeep**	67
Bronco	15
Scout	7
Land Cruiser	7
Misc. (GMC, Suburban)	4
Blazer	-
Jimmy	-
Total	100%

*27 vehicles, listed in detail in Table 4.4.1-3.

**Includes 16 AMC JEeps; 2 Willys Jeeps.

TABLE 4.5.1-3
 PERCENT OF FATAL CRASHES
 INVOLVING ROLLOVER:
 ALL STATES, 1977 FARS

Vehicle	Urban %	Rural %	Total %
Rollovers			
Utility Vehicles	11	36	29
Passenger Cars	2	9	6
Number of Crashes			
Utility Vehicles	134	348	486
Passenger Cars	15,495	19,749	35,304

Table 4.5.3-1

SUMMARY OF PHYSICAL MEASUREMENTS AND HEIGHT OF THE CENTER-OF-GRAVITY

<u>Vehicle</u>	<u>Wheel Base</u>	<u>Track**</u>	<u>Stability Envelope*</u>	<u>Center-of-Gravity from ground</u>	<u>Lateral Acceleration Required to Roll (AY) in G's</u>
<u>Test</u>					
1975 Blazer	106.5 in.	65.75 in.	7002 sq. in.	27.14 in.	1.21
1979 CJ5	83.5	53.25	4446	26.45	1.01
1979 CJ7	93.5	53.25	4979	24.80	1.07
1973 Bronco	92.0	60.00	5520	27.19	1.10
1968 Mod. Bronco	92.0	61.00	5612	28.62	1.07
<u>Comparison</u>					
1971 Pontiac Trans Am	108.5	61.05	6624	18.79	1.62
1971 V.W. Bug	96	52.45	5035	19.38	1.35
1969 Mustang	108	58.5	6318	19.80	1.48
1974 Pinto	94.2	55.0	5181	20.60	1.33
1974 Ford Full Size	121	64.3	7780	20.50	1.57
AMC Pacer	104	60.6	6302	21.38	1.41
Chevrolet Nova	111	60.15	6676	19.03	1.58
1980 AMC Eagle	109	59.0	6431	22.6	1.31
1980 AMC Concord	109	59.0	6431	21.1	1.40

**Where the front and rear tracks differ, value given is the average.

*Stability envelope (track x wheel base) values are approximate.

TABLE 4.6.1-2

PERCENT OF TOTAL CRASHES IN WHICH
 TOTAL DRIVER EJECTION
 FROM THE VEHICLE WAS REPORTED:
 WASHINGTON, 1976

Make	Total Ejection %
Blazer	1
Bronco	2
Jeep	10
Scout	2
Land Cruiser	4
Passenger car	1

THE HSRC STUDIES

The Highway Safety Research Center of the University of North Carolina has published two studies bearing on the Jeep CJ:

- "A Comparison of the Crash Experience of Utility Vehicles, Pickup Trucks and Passenger Cars," September, 1981, authored by Reinfurt et al. of HSRC and co-authored by O'Neill et al. of the Insurance Institute for Highway Safety, and,

- "A Further Look at Utility Vehicle Rollovers," authored by Reinfurt et al., August, 1984. Both studies were supported by grants from the Insurance Institute for Highway Safety.

1. "Comparison"

"Comparison" focuses on three utility vehicles -- the CJ-5, the Ford Bronco and the Chevrolet Blazer -- representing "well over half" of all such vehicles in use. It studied "the overall crash experience of these vehicles in Maryland and in North Carolina, together with the national fatal crash experience" as recorded by FARS (Fatal Accident Reporting System maintained by the National Highway Traffic Safety Administration).

Specifically, its data sources were statewide police-reported crash data for North Carolina during 1973-78; statewide police-reported crash data for Maryland, 1974-78; and FARS data, 1978-79. It analyzed these in the context of vehicle registration data obtained from R.L. Polk & Co. for the period beginning 1975.

Principal results of the study pertaining to the Jeep CJ-5, shown in the following tables and graphs, were as follows:

- CJ-5 had substantially higher single-vehicle (but not multi-vehicle) crash involvement rates than other studied utility vehicles. (Comparison, p. 10, Table 1.)
- CJ-5 had substantially higher single-vehicle rollover rates than the other studied vehicles. (Comparison, p. 12, Table 2.)
- Utility vehicles as a class had much higher rates of rollover, serious injuries and deaths than pickups or passenger cars (Comparison, p. 13, Figure 1) and the CJ-5 had very much higher rates than the other leading utility vehicles. (Comparison, p. 14, Figure 2.)
- When involved in single-vehicle crashes, the CJ-5 had the highest percentages of rollover of the vehicles studied. (Comparison, p. 16, Table 3.)
- For crashes of all types, belted drivers fared better than unbelted drivers in being seriously injured -- although utility drivers fared worst in both categories. (Comparison, p. 27, Figure 5.) Although this difference held true for CJ-5 drivers as well, it is noteworthy that whether belted or unbelted, CJ-5 drivers had substantially higher percentages of serious injury than drivers of the other leading utility vehicles studied -- and that the belted CJ-5 drivers had a worse record than even the unbelted Bronco and Blazer drivers.

(Comparison, p. 28, Figure 6.)

-- "Since the crash-involved Jeep CJ-5s in this study were more often driven by young drivers than the other crash-involved vehicles, an examination of the possible effects of driver age on rollover rates was conducted. It was found that any age effect was at most marginal in either Maryland or North Carolina." (Emphasis added.)

An examination of rollover percentages by driver age groups for the studied "leading" utility vehicles in the two states, both as a group and individually, showed that "the rollover rates for the Jeep CJ-5 and the Bronco exceed that of the All Utility Vehicle group with the Blazer rollover rates clearly lower yet. This suggests that age is not an important factor for any particular utility vehicle model involved in rollover crashes.

(Emphasis added.)" (Comparison, p. 35, Figures 7; p. 36, Figure 8.)

Conclusion: "In virtually every category of comparison -- crash involvement rates (particularly single vehicle), serious (A+K) driver injuries, rate of overturn, serious driver injuries in rollover crashes, serious injuries for belted and unbelted drivers -- the Jeep CJ-5 had the least favorable results of the various vehicles studied. The fact that the Jeep CJ-5 is usually sold as an open-top vehicle undoubtedly contributed to its injury and fatality experience."

Table 1. Crash involvement rates (per 10,000 registered vehicles) by type of crash.

Maryland 1975-78; North Carolina 1975-78

Type of Vehicle	MARYLAND ¹			NORTH CAROLINA ¹		
	Single Vehicle Rate	Multi-Vehicle Rate	Overall Rate (N)	Single Vehicle Rate	Multi-Vehicle Rate	Overall Rate (N)
Utility Vehicles	145	662	807 (2422)	145	358	503 (3823)
→ Jeep CJ-5	273	666	939 (578)	228	382	610 (1484)
Ford Bronco ²	142	487	629 (177)	162	275	438 (465)
Chevrolet Blazer ^{3,4}	120	850	981 (1076)	95	447	542 (998)
Pickup Trucks	95	745	840 (29318)	62	353	415 (38441)
Ford F-100, F-150	96	789	885 (9682)	72	397	470 (14197)
Chevrolet C-10, K-10	98	718	816 (6903)	65	390	455 (12746)
Toyota	147	944	1091 (788)	138	582	720 (1365)
Datsun	133	837	970 (1562)	85	461	546 (1290)
Passenger Cars	84	1,012	1115 (407062)	119	472	591 (283725)
Subcompact	103	1,034	1138 (115448)	160	503	663 (77472)
Compact	88	968	1056 (88375)	150	504	654 (53829)
Intermediate	84	1,102	1186 (119292)	111	466	577 (83790)
Full-Size	62	998	1060 (83947)	73	434	507 (68634)

¹Excludes crashes with pedestrians, bicycles, trains, etc.
²Excludes 1978 models which had a different wheelbase.
³Includes the GMC Jimmy, an essentially identical vehicle.
⁴Excludes 1972 models which had a different wheelbase.

Table 2. Rollover rates (per 10,000 registered vehicles)
by type of crash.

Maryland 1975-78; North Carolina 1975-78

Type of Vehicle	MARYLAND ¹		NORTH CAROLINA ¹	
	Single Vehicle Rate	Multi-Vehicle Rate	Single Vehicle Rate	Multi-Vehicle Rate
Utility Vehicles	71.0	10.0	55.5	6.2
Jeep CJ-5	180.2	32.5	95.8	9.5
Ford Bronco ²	88.8	7.1	68.6	8.5
Chevrolet Blazer ^{3,4}	31.0	0.9	21.7	3.3
Pickup Trucks	17.3	1.9	11.8	1.2
Ford F-100, F-150	14.4	2.0	12.8	1.1
Chevrolet C-10, K-10	15.1	1.4	12.3	1.1
Toyota	41.5	4.2	38.0	7.4
Datsun	41.0	5.6	25.4	2.5
Passenger Cars	8.5	1.0	15.1	0.7
Subcompact	18.7	2.3	33.8	1.6
Compact	8.0	0.8	20.2	1.2
Intermediate	4.0	0.4	8.9	0.3
Full-Size	2.2	0.4	3.6	0.2

¹Excludes crashes with pedestrians, bicycles, trains, etc.

²Excludes 1978 models which had a different wheelbase.

³Includes the GMC Jimmy, an essentially identical vehicle.

⁴Excludes 1972 models which had a different wheelbase.

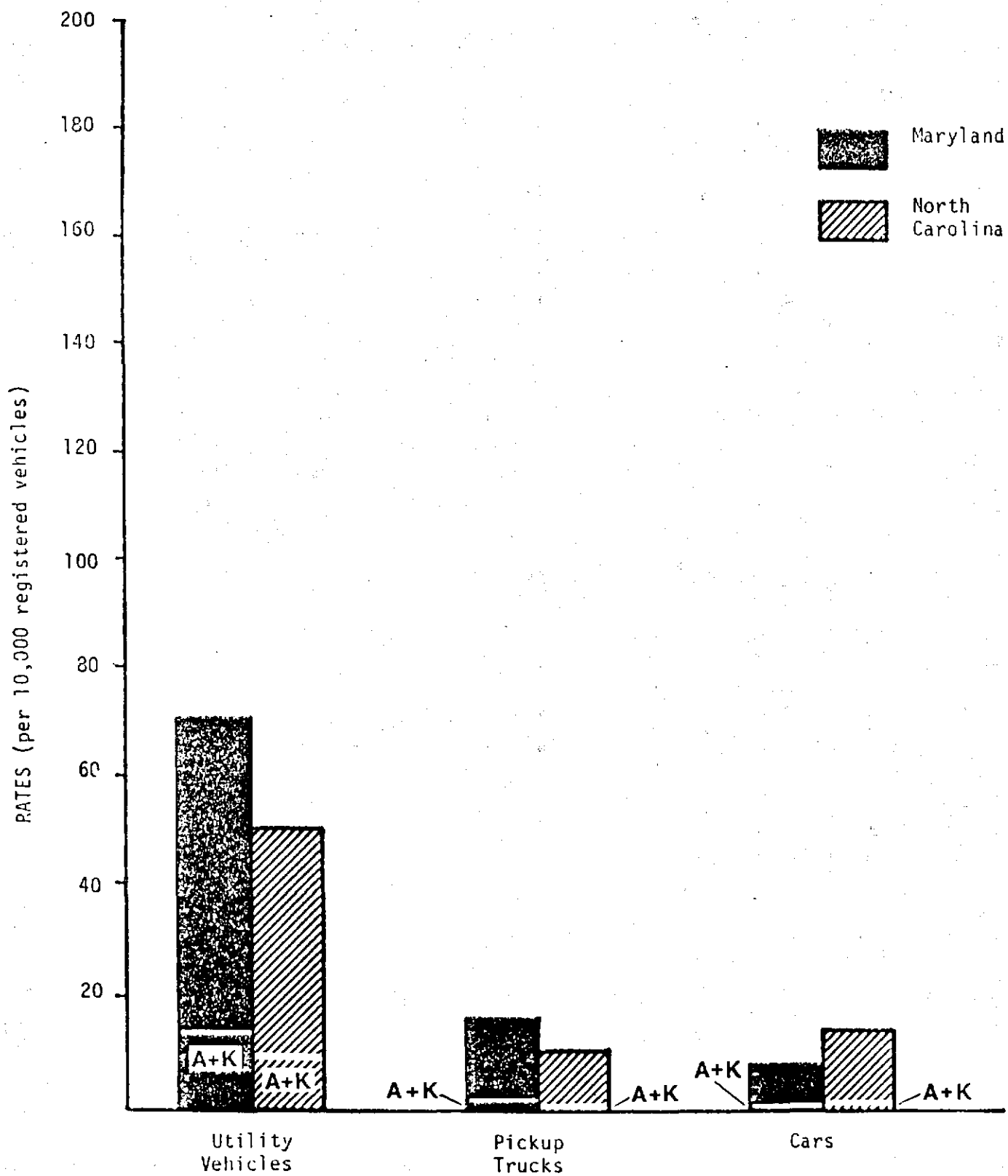


Figure 1. Single vehicle rollover and serious driver injury rates (per 10,000 registered vehicles) for various vehicle types.

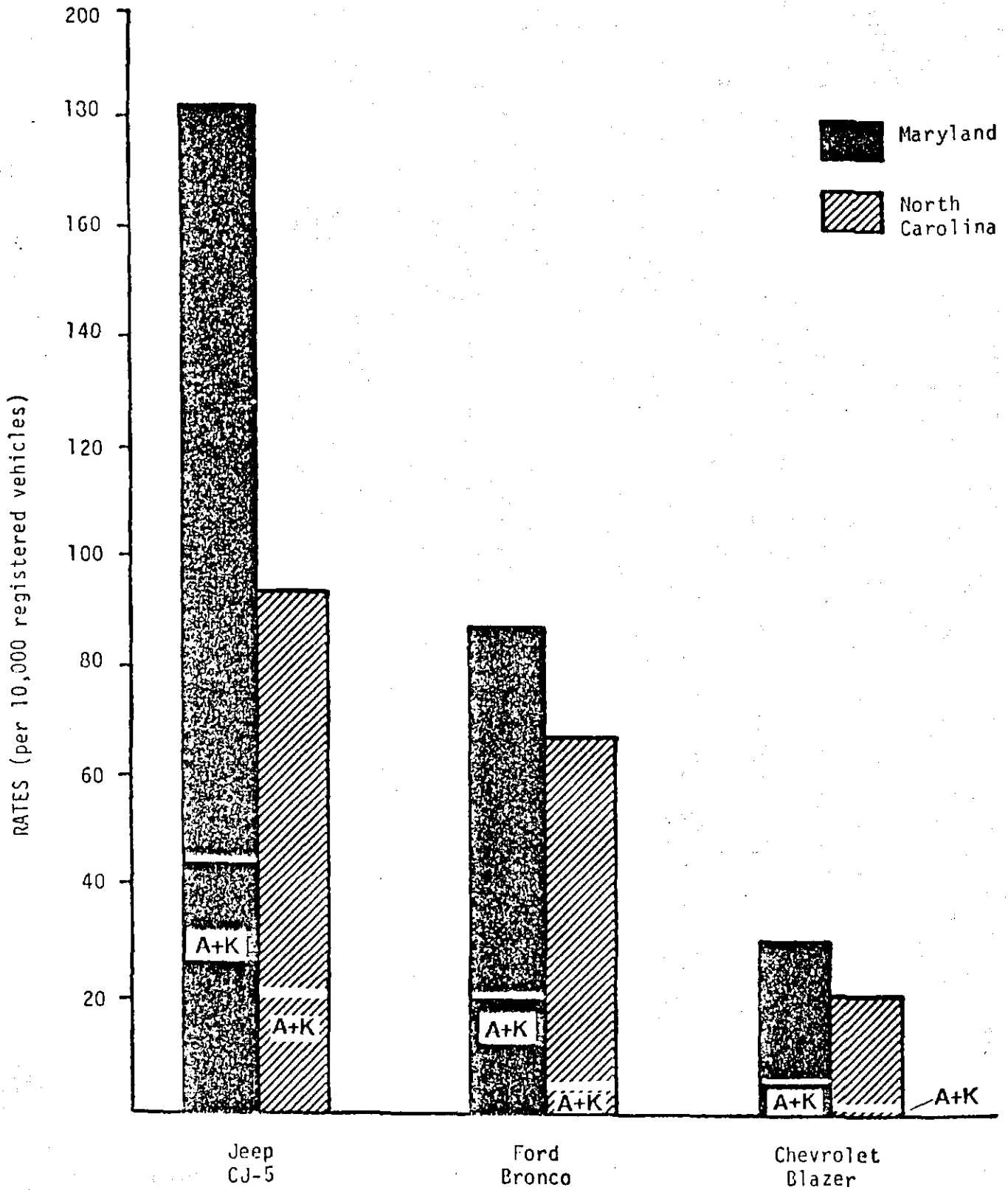


Figure 2. Single vehicle rollover and serious driver injury rates (per 10,000 registered vehicles) for the leading utility vehicle models.

Table 3. Percentages of crash-involved vehicles that rolled over by type of crash.
Maryland 1974-78; North Carolina 1973-78

Type of Vehicle	MARYLAND ¹		NORTH CAROLINA ¹	
	Rollover %		Rollover %	
	Single Vehicle Crash	Multi-Vehicle Crash	Single Vehicle Crash	Multi-Vehicle Crash
Utility Vehicles	49.0%	1.5%	36.6%	1.7%
↙ Jeep CJ-5 ²	↙ 66.5	4.6	↙ 40.2	2.6
Ford Bronco ²	63.0	1.9	37.4	3.3
Chevrolet Blazer ^{3,4}	24.8	0.1	22.5	0.6
Pickup Trucks	18.2	0.3	18.7	0.3
Ford F-100, F-150	15.3	0.2	17.5	0.3
Chevrolet C-10, K-10	15.2	0.2	18.1	0.3
Toyota	30.0	0.5	27.3	1.2
Datsun	29.2	0.6	30.2	0.6
Passenger Cars	10.1	0.1	12.6	0.2
Subcompact	18.0	0.2	20.0	0.3
Compact	9.6	0.1	13.5	0.2
Intermediate	4.7	0.0	8.1	0.1
Full-Size	3.5	0.0	5.0	0.0

¹Excludes crashes with pedestrians, bicycles, trains, etc.

²Excludes 1978 models which had a different wheelbase.

³Includes the GMC Jimmy, an essentially identical vehicle.

⁴Excludes 1972 models which had a different wheelbase.

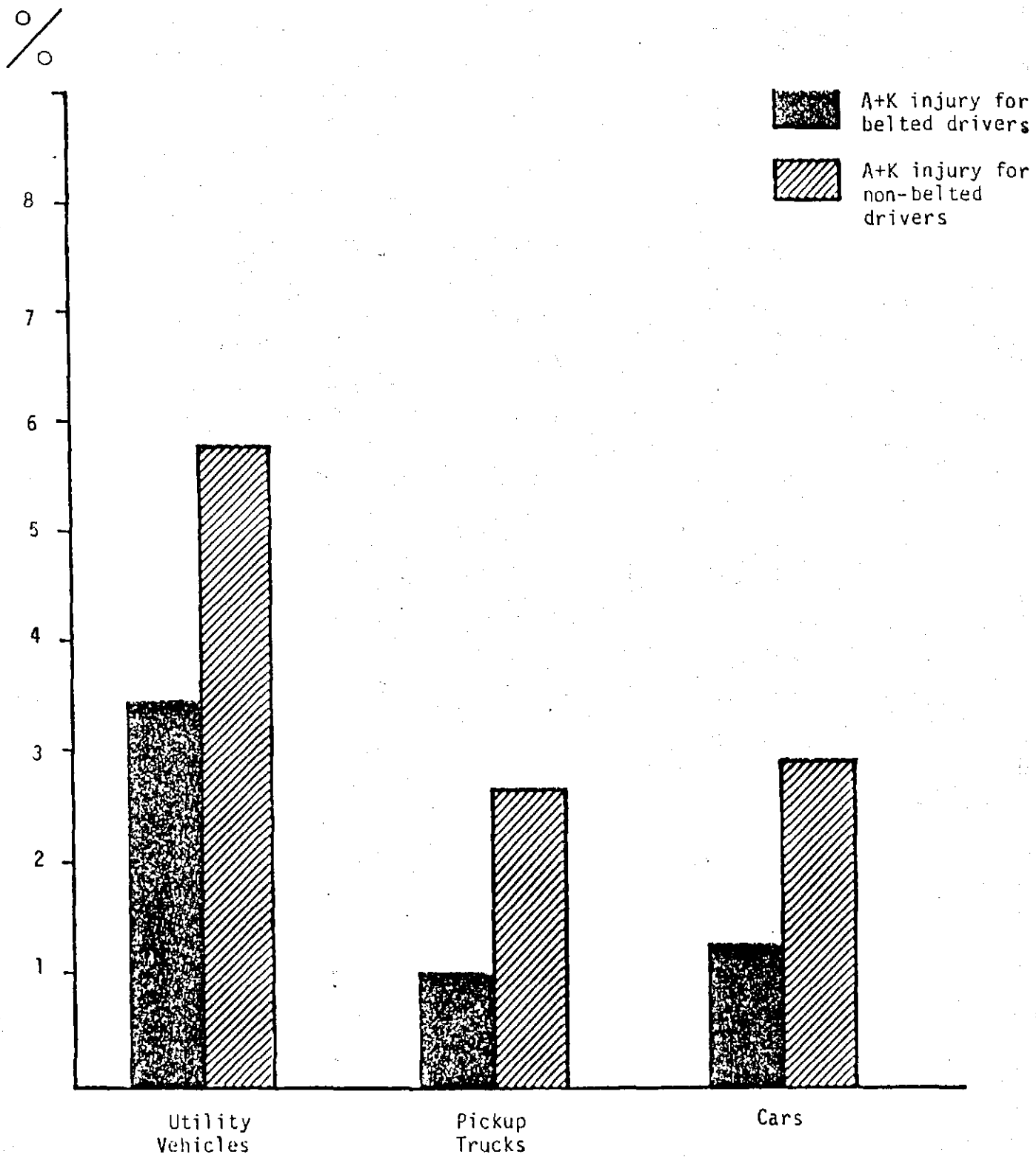


Figure 5. Driver serious injury percentages within belt usage categories for various vehicle types-- North Carolina

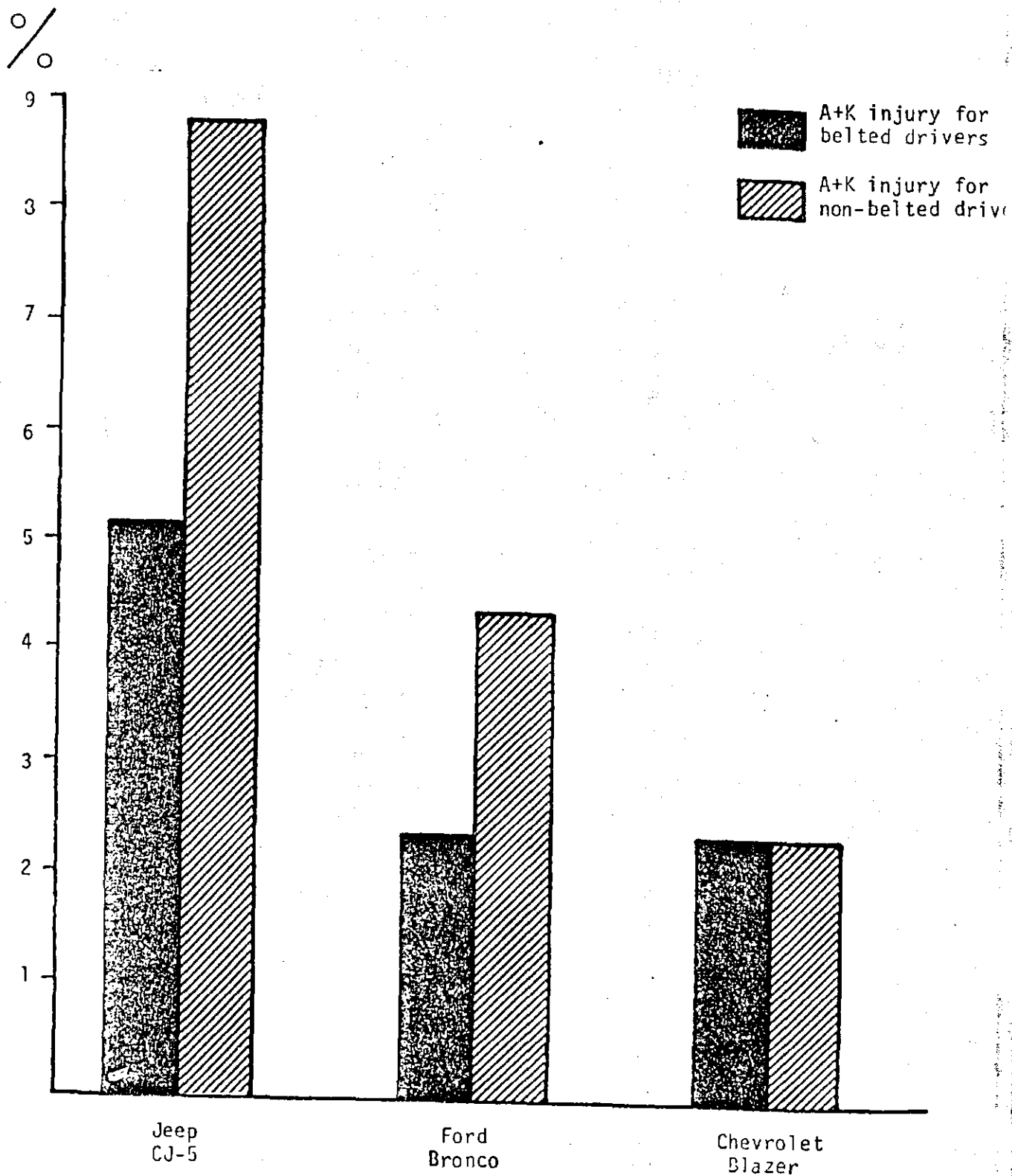
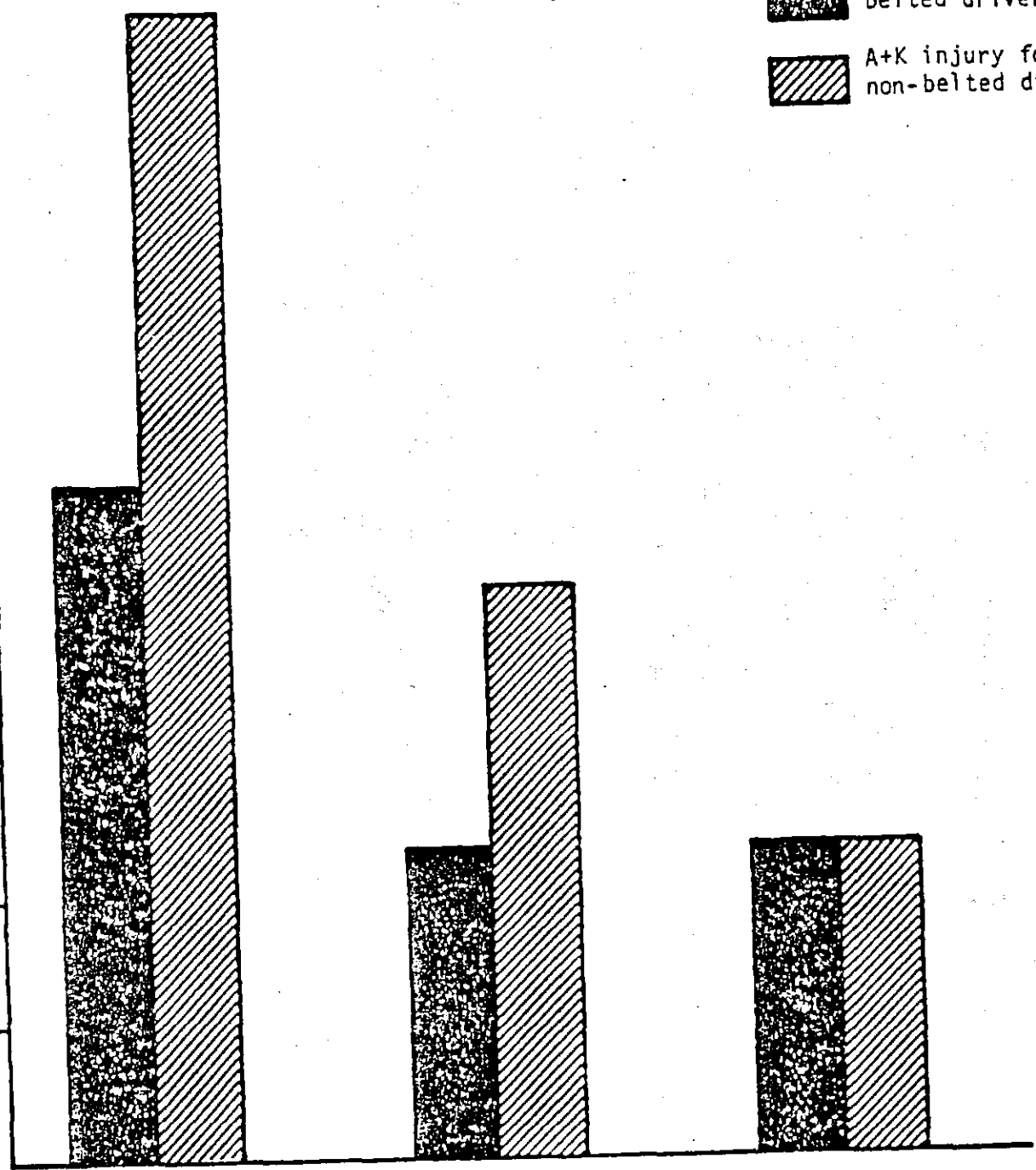


Figure 6. Driver serious injury percentages within belt usage categories for the leading utility vehicle models-- North Carolina

0 / 0

9
3
7
6
5
4
3
2
1

A+K injury for belted drivers
A+K injury for non-belted dri



Jeep
CJ-5

Ford
Bronco

Chevrolet
Blazer

Figure 6. Driver serious injury percentages within belt usage categories for the leading utility vehicle models-- North Carolina

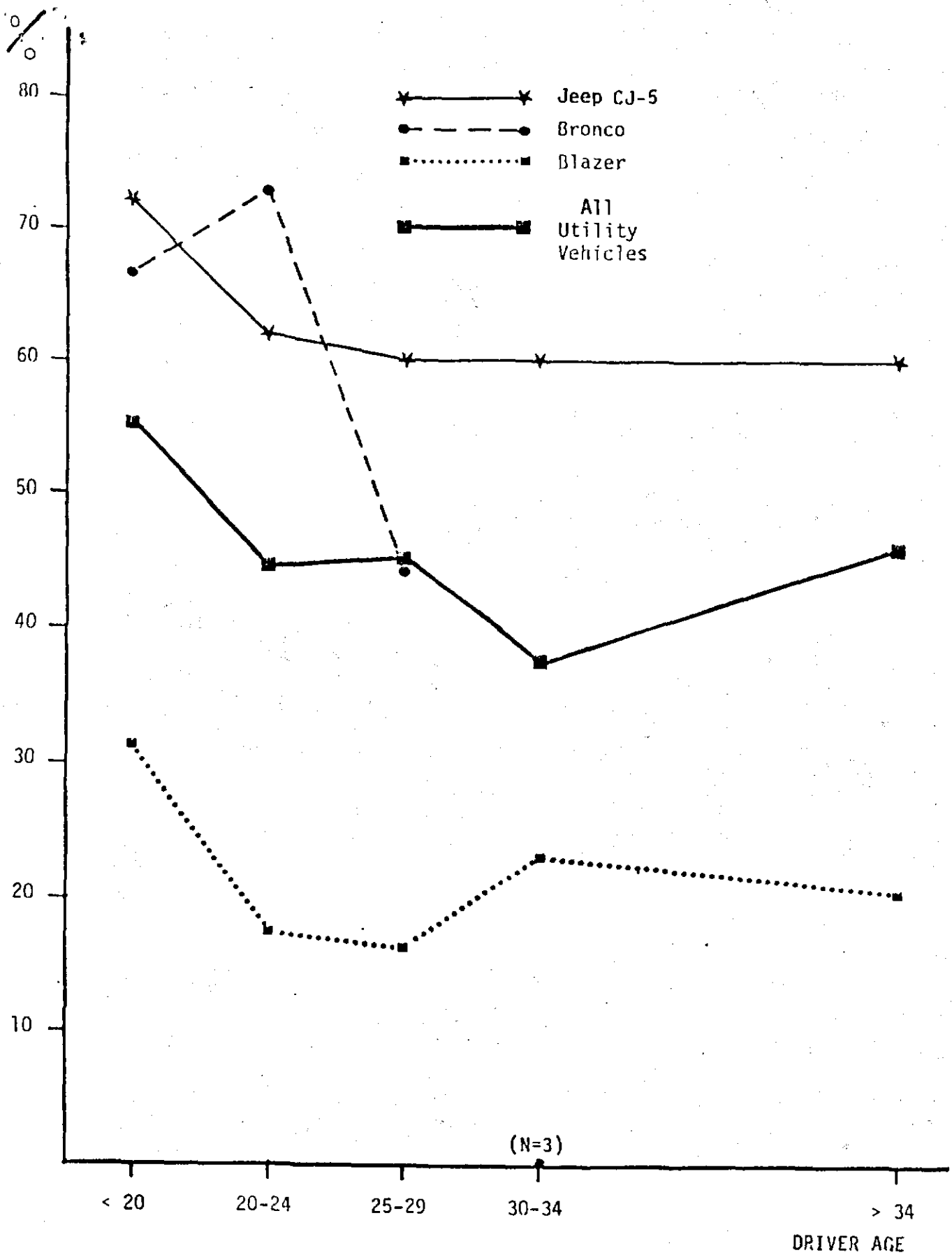


Figure 7. Utility vehicle rollover percentages by driver age for single vehicle crashes in Maryland, 1975-78.

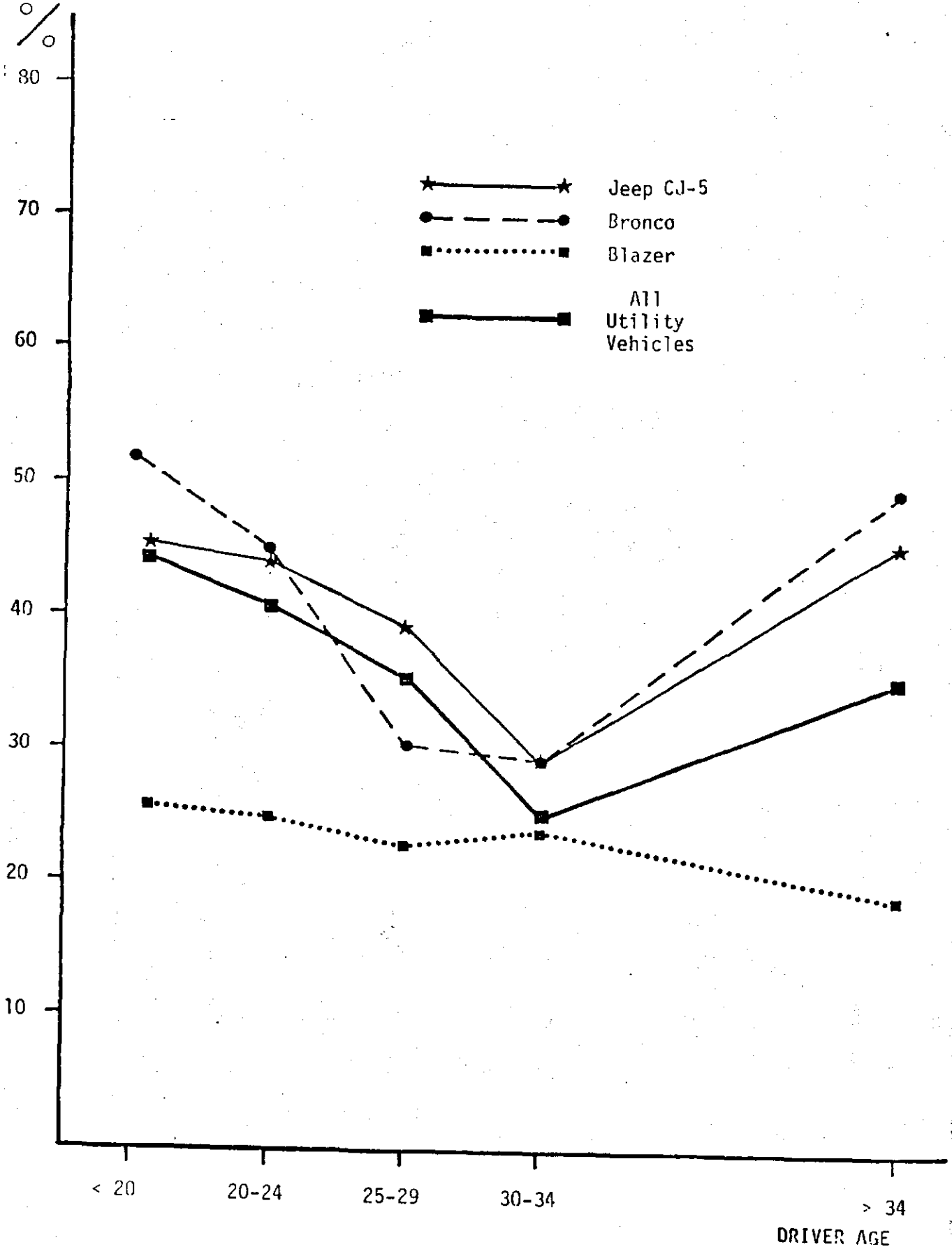


Figure 8. Utility vehicle rollover percentages by driver age for single vehicle crashes in North Carolina, 1975-78.

2. "Further Look"

"Further Look" examined, in addition to the CJ-5, Bronco and Blazer and comparison pickup trucks and passenger cars, the CJ-7 and International Scout. It covered the model year period 1972-82, although not the entire period for every model.

Because of consistency between the North Carolina and Maryland results reported in "Comparison," "Further Look" used only North Carolina crash-report data. These were drawn from some 600,000 reported accidents during 1979-82. It analysed these in the context of "denominator" data including not just the R.L. Polk registration lists but in addition, odometer readings data from the state's motor vehicle inspection program. The latter enabled some mileage-exposure analyses of the crash data.

Principal overall results of "Further Look" included these:

- Both CJ-5 and CJ-7 had substantially higher single-vehicle crash rates (but not multi-vehicle rates) than the other studied utility vehicles (Further Look, p. 12, Table 1).
- Both CJ-5 and CJ-7 had substantially higher single-vehicle rollover rates than the other studied vehicles. (Further Look, p. 14, Table 2, p. 15, Figure 1.)
- When involved in single-vehicle crashes, the CJ-5 and CJ-7 had the highest percentages of rollover of the vehicles studied (Further Look, p. 18, Table 3).

These and other findings of "Further Look" corroborated those of "Comparison." In addition, "Further Look" examined a number of variables -- including belt use and age, looked at also in the earlier study -- with the following results:

Single-Vehicle Non-Collision Overturn In Road: When involved in single-vehicle crashes, CJ-5 and CJ-7 were far more likely to overturn in the road than other compared utility vehicles.

(Further Look, p. 28, Figure 4.)

Belt Use: Non-belted drivers of CJ-5 and CJ-7 had substantially higher percentages of serious injury in crashes than such drivers of compared utility vehicles. Although belted CJ-5 and CJ-7 drivers had lower serious-injury percentages than belted drivers, they had higher percentages than belted drivers of the compared vehicles, with the exception of the 1972-77 model Ford Bronco. This exception is due to a small-numbers problem: the 1972-77 Ford Bronco data contained only 17 single-vehicle crashes involving belted drivers, with one serious injury. (Further Look, p. 31, Figure 5.)

Driver Age: ". . . age is not an important factor for any particular utility vehicle model involved in rollover crashes," it is indicated by the rollover percentages of representative utility vehicles by driver age for single-vehicle crashes, since "the rollover percentages for the Jeep CJ-5 exceeded those of the reference population of all utility vehicles in virtually every age category, while those of the Chevrolet Blazer were consistently lower across age groups. (Emphasis added.)" (Further Look, p. 35, Figure 6.)

Mileage: ". . .a sample of mileage data was examined which indicated that utility vehicles average approximately 1000 fewer miles per years than either half-ton pickups or passenger cars." (Further Look, p. 41.) Thus hyperexposure of the former did not account for their different rollover experience.

Other Variables: Even when such factors as driver sex, intoxication, speed and driver violation were controlled for separately and in combination, single-vehicle rollover rates for the CJ-5 and CJ-7 remained significantly higher (except for the CJ-7 when driver violations were controlled for). (Further Look, p. 38, Table 12.)

Conclusion: "In virtually every category of comparison -- crash involvement rates (overall and single vehicle), serious (A+K) driver injury rates, rate of overturn (single vehicle and multi-vehicle), serious driver injuries in rollover crashes, percentages of vehicles in single vehicle crashes that overturned in roald, serious injuries for belted and unbelted drivers -- the Jeep CJ-5 and the Jeep CJ-7 had the least favorable results of the various vehicles studied." (Further Look, p.. 40.)

A note about the 1972-77 Ford Bronco: Although not as poor a performer as the CJs, the pre-1978 Bronco had a worse record in general than the other studied utility vehicles. Starting with the 1978 model, the Bronco's wheelbase was lengthened. Since that change the Bronco's performance has improved substantially.

Table 1. Crash involvement rates (per 10,000 registered vehicles) by type of crash.¹
North Carolina 1979-82

Type of Vehicle	Single Vehicle Rate	Multi-Vehicle Rate	Overall	
			Rate	(N)
Utility Vehicles	145 [145] ²	342 [358]	487 [503]	(6804)
↙ Jeep CJ-5	↙ 214 [228]	366 [382]	580 [610]	(2404)
↙ Jeep CJ-7	↙ 172	368	540	(1050)
Ford Bronco				
1972-77	105 [162]	206 [276]	311 [438]	(361)
1978-82	113	317	430	(432)
Chevrolet Blazer ^{3,4}	95 [95]	368 [447]	463 [542]	(1608)
International Scout	98	309	407	(437)
Toyota Land Cruiser	121	287	408	(264)
Pickup Trucks (1/2 ton)	59 [62]	279 [353]	338 [415]	(51,183)
Ford F-100, F-150	60 [72]	289 [397]	349 [470]	(18,401)
Chevrolet C-10, K-10 ⁵	54 [65]	277 [390]	331 [455]	(21,483)
Toyota	114 [138]	386 [582]	500 [720]	(3848)
Datsun	79 [85]	362 [461]	441 [546]	(3072)
Passenger Cars	81 [119]	463 [472]	544 [591]	(458,843)
Subcompact	107 [160]	501 [503]	608 [663]	(152,050)
Compact	83 [150]	466 [504]	549 [654]	(104,163)
Intermediate	75 [111]	477 [466]	552 [577]	(129,955)
Full-Size	47 [73]	385 [434]	432 [507]	(72,675)

¹Excludes crashes with pedestrians, bicycles, trains, etc.

²Rate reported in Reinfurt, et al. (1981).

³Includes the GMC Jimmy, an essentially identical vehicle.

⁴Excludes 1972 models which had a different wheelbase.

⁵Includes the GMC C-1500 and K-1500 which are essentially identical to the Chevrolet C-10 and K-10.

Table 2. Rollover rates (per 10,000 registered vehicles)
by type of crash.¹
North Carolina 1979-82

Type of Vehicle	Single Vehicle Rate	Multi-Vehicle Rate	Overall Rate
Utility Vehicles	64.0 [55.5] ²	6.8 [6.2]	70.8
↘ Jeep CJ-5	↘ 103.5 [95.8]	10.9 [9.5]	114.4
↘ Jeep CJ-7	↘ 83.9	10.8	94.7
Ford Bronco			
1972-77	50.0 [68.6]	4.3 [8.5]	54.3
1978-82	42.8	3.0	45.8
Chevrolet Blazer ^{3,4}	29.6 [21.7]	3.8 [3.3]	33.4
International Scout	33.6	3.7	37.3
Toyota Land Cruiser	78.7	3.1	81.8
Pickup Trucks (1/2 ton)	14.0 [11.8]	1.3 [1.2]	15.3
Ford F-100, F-150	14.0 [12.8]	1.3 [1.1]	15.3
Chevrolet C-10, K-10 ⁵	11.6 [12.3]	1.0 [1.1]	12.6
Toyota	37.2 [38.0]	2.6 [7.4]	39.8
Datsun	22.4 [25.4]	3.4 [2.5]	25.8
Passenger Cars	12.7 [15.1]	0.9 [0.7]	13.6
Subcompact	25.2 [33.8]	1.8 [1.6]	27.0
Compact	12.1 [20.2]	0.8 [1.2]	12.9
Intermediate	6.5 [8.9]	0.5 [0.3]	7.0
Full-Size	3.6 [3.6]	0.3 [0.2]	3.9

¹Excludes crashes with pedestrians, bicycles, trains, etc.

²Rate reported in Reinfurt, et al. (1981).

³Includes the GMC Jimmy, an essentially identical vehicle.

⁴Excludes 1972 models which had a different wheelbase.

⁵Includes the GMC C-1500 and K-1500 which are essentially identical to the Chevrolet C-10 and K-10.

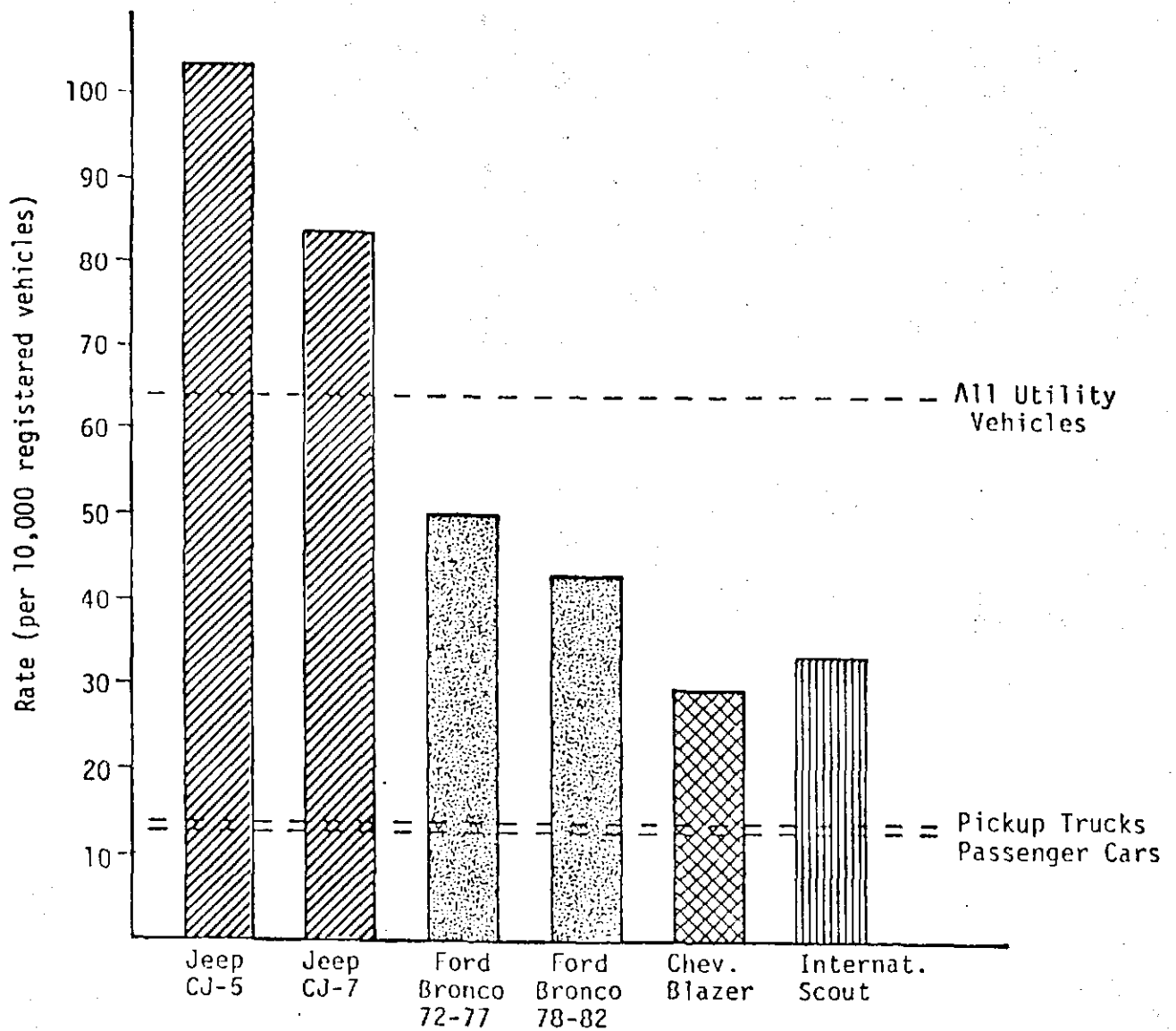


Figure 1. Single vehicle rollover rates (per 10,000 registered vehicles) for various utility vehicle models, compared with all utility vehicles, half-ton pickup trucks and passenger cars.

Table 3. Percentages of crash-involved vehicles that rolled over by type of crash.¹
North Carolina 1979-82

Type of Vehicle	Single Vehicle Crash	Multi-Vehicle Crash
Utility Vehicles	45.2 [36.6] ²	2.1 [1.7]
↙ Jeep CJ-5	↙ 49.3 [40.2]	3.1 [2.6]
↙ Jeep CJ-7	↙ 49.7	3.0
Ford Bronco		
1972-77	48.3 [37.4]	2.2 [3.3]
1978-82	39.8	1.0
Chevrolet Blazer ^{3,4}	31.8 [22.5]	1.1 [0.6]
International Scout	35.3	1.2
Pickup Trucks (1/2 ton)	24.5 [18.7]	0.5 [0.3]
Ford F-100, F-150	24.1 [17.5]	0.5 [0.3]
Chevrolet C-10, K-10 ⁵	22.0 [18.1]	0.4 [0.3]
Toyota	33.1 [27.3]	0.7 [1.2]
Datsun	28.7 [30.2]	1.0 [0.6]
Passenger Cars	16.0 [12.6]	0.2 [0.2]
Subcompact	23.8 [20.0]	0.4 [0.3]
Compact	14.8 [13.5]	0.2 [0.2]
Intermediate	8.9 [8.1]	0.1 [0.1]
Full-Size	7.9 [5.0]	0.1 [0.0]

- ¹Excludes crashes with pedestrians, bicycles, trains, etc.
²Percentage reported in Reinfurt, et al. (1981).
³Includes the GMC Jimmy, an essentially identical vehicle.
⁴Excludes 1972 models which had a different wheelbase.
⁵Includes the GMC C-1500 and K-1500 which are essentially identical to the Chevrolet C-10 and K-10.

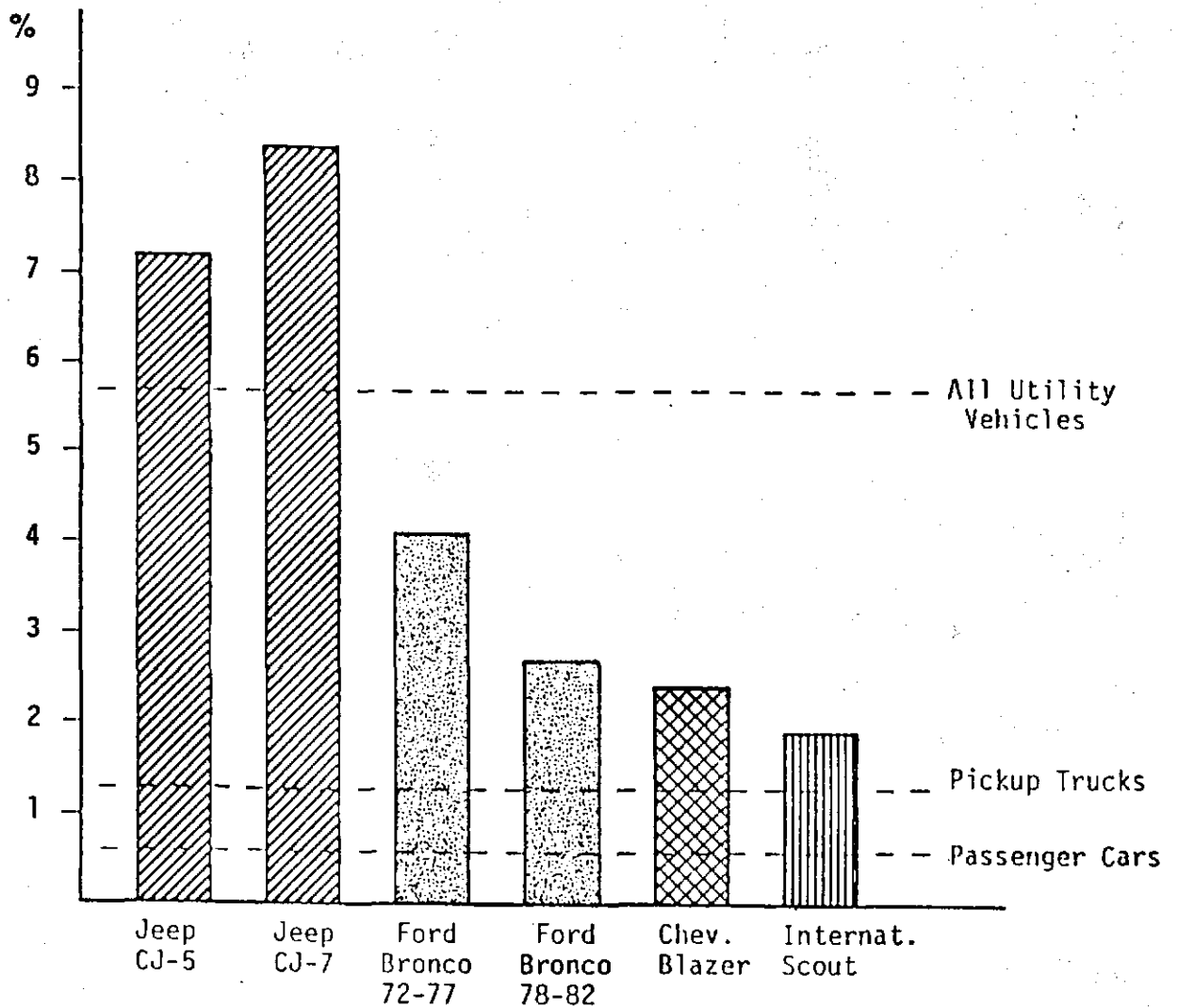


Figure 4. Percentages of vehicles in single vehicle crashes that overturned in road for various utility vehicle models, compared with all utility vehicles, half-ton pickup trucks and passenger cars.