- Campbell, B.J. (1981). Three studies of North Carolina accident data: 1) The use of North Carolina accident data for the study of ejection. 2) The use of the accident report form's computerized narrative description to study the contribution of vehicle defects to accident occurrence. 3) An analysis of reported tire defects in North Carolina accidents. Chapel Hill, NC: University of North Carolina Highway Safety Research Center.

highway
Safety
Research
Center

university
of north
carolina

chapel hill, n.c.

THREE STUDIES OF NORTH CAROLINA ACCIDENT DATA

1. The Use of North Carolina Accident Data for the Study of Ejection

2. The Use of the Accident Report form's Computerized Narrative Description to Study the Contribution of Vehicle Defects to Accident Occurrence

3. An Analysis of Reported Tire Defects in North Carolina Accidents

B. J. Campbell

September 1981
HSRC-PR101

THE USE OF NORTH CAROLINA ACCIDENT DATA FOR THE STUDY OF EJECTION

Purpose

The purpose of this analysis is to explore the use of computerized accident narratives for the purpose of detecting the presence of ejection and studying the phenomenon. The North Carolina accident report form does not have a specific check box to indicate the occurrence of occupant ejection; however, the officer sometimes mentions this occurrence when he writes the narrative description of the accident. It is of interest to find out whether meaningful ejection data are retrievable as a result of this officer practice, and in view of the importance of ejection. Also ejection is an item of interest to NHTSA and absence of that item is one of the ways in which NHTSA presumably considers the N.C. system to fall short.

Narrative description

Across the U.S. virtually every police accident report form includes, in addition to the various check boxes and blanks, a space where the officer writes a narrative description of the accident. This narrative is usually given in conjunction with a pictorial sketch of the crash.

Information on the narrative is used later by accident coders to help secure the necessary codes. A skillful clerk can derive significant information by reconciling the narrative description, sketch, and the various check boxes on the form. Regrettably, however, the narrative description itself is ususally not stored in such a way that retrieval is feasible.

In a state the size of North Carolina about 160 thousand accidents per year are reported, each of which has a narrative. The reports are stored in filing cabinets and/or put on microfilm and therefore are usually retrievable only by pulling them out and reading them.

This is regrettable because the narrative is a particular valuable source of information regarding those rare events not covered on the form by a check box. If one reflects on the matter, it becomes apparent that when an accident report form contains a prepared check box for a particular event, then, by definition, those particular events are thought by the form designers to be sufficiently frequent and of sufficient importance to warrant a check box. Equally obvious is the fact that events which are much more rare than the typical accident phenomenon, or new unanticipated factors in the accident picture, are not going to have a dedicated a check box on the form. One can only place a check box on the form regarding events already known to exist and be important.

To detect new accident trends (or to document "old" phenomena not captured in the investigation) one needs some sort of a "early warning" system. The narrative is valuable in this respect. A trained officer, particularly one who is oriented towards this sort of thing, will often go out of his way to report relevant, unusual phenomena in the narrative.

North Carolina has a unique way of capturing the information contained in narratives. Since 1971 North Carolina has followed the practice of recording on computer tape the narrative words which the officer writes down. This means that tens of millions of officer narrative words have been captured over the years.

Merely recording these words does not, however, make them any more accesible than if they existed as "hard copy" in filing drawers or on microfilm. In conjunction with recording the words there has been a continuing program of software development by which the computer "reads" narratives rapidly and can extract, for further analysis, narratives containing a specified search word or combination of words.

In the present case the task of the analyst is to define words or phrases which an officer would use to describe a vehicle occupant being ejected or falling from the vehicle during the course of the accident sequence. Then these search words can be compared by the computer against an accident data subset--a test file. The full accident narratives of all cases with "hits" can then be printed out for reading by the analyst. Upon reading the narratives a judgment is made as to whether the list of search words is satisfactory, whether more words are needed, or whether some search words are bringing in too many "false alarms".

Based on these considerations the search word list is refined before performing a full scale search. Once the narratives from the complete file are extracted, the case numbers of each narrative containing a "hit" can be used to match up with the digital information (from the check boxes) on the case. Cases can then be analyzed, and cross tabulations generated.

Ejection

Ejection as a dangerous phenomenon in an automobile crash has been recognized for decades. In the early 1950's the Indiana Highway Patrol reported an informal analysis which indicated that persons who were ejected in a crash, frequently seemed to have more severe injuries than those not ejected in similar accidents.

The term ejection refers to a situation in which, during the violent vehicle movements in the crash sequence, there is sufficient vehicle deformation and sufficient occupant movement within the car such that the door comes open and the occupant falls or is thrown through the open door onto the ground. Ejection can also include a situation in which an occupant is thrown through the windshield, window, or other car opening.

The folklore with respect to ejection had been (and to some degree continues to be) that ejection is desirable. One still occasionally hears people refer to being "thrown clear" in a crash as if this were something desireable. It must be admitted that there could be isolated circumstances in which one might fare better to be thrown out of a car than to stay in the car in the same crash. But this is the exception rather than a rule.

The first systematic analysis of ejection was reported in 1958 by Tourin* et al and showed that in a series of crashes standardized by degree of vehicle deformation, the net risk of being seriously injured or killed when ejected was about 2 1/4 fold higher than being retained in crashes of the same type and deformation.

It is important to realize that there is a discrepancy in the apparent findings regarding the seriousness of ejection. If one simply includes all crashes in which someone is ejected and calculates the percent of serious/fatal injury and compares that to all crashes in which no one is ejected, the injury and death percentages will differ greatly -- by five fold or more. However, part of that difference is because the crash severity itself is so different between the ejection and non-ejection groups.

As a group, crashes from which someone is ejected are considerably more severe than crashes in which no one is ejected. In the Tourin study cited above, the raw figures indicate a five to 1 elevation in the probability or serious/fatal injury for ejectees. However, when one factors out the effect of crash severity, instead of a five fold risk increase for ejection, there is, instead, about a two and a half fold penalty.

---

*Tourin, Boris, "Ejection and Automobile Fatalities," Public Health Reports, 73(5), May 1958, pp. 381-391.

That situation is well kept in mind in view of recent statements claiming to show an extremely high risk difference for ejection v. non-ejection.

Nonetheless, ejection very adversely affects the probability of survival; therefore it is not surprising that countermeasures are directed towards ejection control. Lap and shoulder belts are an excellent countermeasure. It is unlikely that a person will be ejected, even partially, if he is properly belted. Also, since about 1956 car manufacturers have installed interlocking door latches on vehicles, designed to resist door opening even if there is some structural deformation of the car.

A variety of door latch refinements have been introduced over the years, and reports of their effectiveness have been reported. These studies showed that (1) there were some improvements in the first generation of door locks beginning in the late 1950's*; (2) there were some significant corporate differences**, and (3) second generation door latches continued the improvement***.

However, the literature is more or less silent on further improvement since that time. The goal of the present study is to see whether there is evidence of further ejection improvement subsequent to the early 1960's.

---

*Garrett, John W. "An Examination of Door Latch Effectiveness for Pre 1956 v. Post 1955 Automobiles," ACIR of Cornell University, NYC, July 1961.

**Campbell, B.J., "A Review of ACIR Findings," Proceedings 8th. Stapp Car Crash Conference, Wayne State Univ. Press, Detroit, 1966.

***Garrett, John W., "The Safety Performance of 62-63 Automobile Door Latches and Comparison with Earlier Latch Designs, Cornell Aeronautical Laboratory, VJ-1823-R7, November 1964.

Procedure

In this study the procedure is

(1) identify cases in which the accident narrative reveals that ejection occurred,

(2) study the narratives and distinguish between ejection (a person forcibly thrown out of the car) and instances in which a person falls from the car. For purposes of this study, the category falling out of a moving vehicle is ignored,

(3) once the true cases involving ejection are identified, the narrative is scanned to learn from which vehicle the occupant was ejected.

(4) Then that narrative is linked with the digital accident variables recorded for the same crash.

It then becomes possible to examine the relative frequency of ejection as a function of accident, driver, or vehicle variables.

It should be noted that the overall frequency of ejection in the North Carolina data is lower than that reported in other samples. A reason for this is that the North Carolina data represents all reportable accidents, whereas other accident files that deal with ejection are more severe accident samples. Since ejection occurs relatively more frequently in more severe crashes, it follows that a crash sample comprised of more severe crashes will show a higher proportion of ejection.

Cornell Aeronautical Laboratory data included only accidents serious enough to produce injury. The great bulk of the North Carolina file would not even have appeared in such a sample. Also, the NHTSA/MDAI case studies were often quite severe. Further, some of the special studies like the National Crash Severity Study (collected by NHTSA) included only vehicles damaged badly enough in the crash to require being towed away. Thus most NC accidents severe enough to result in ejection would probably be severe enough to be included in the other samples, but the great bulk of NC non-ejection cases would not have appeared in the other samples. Thus, the obtained percent ejection is lower in NC data.

It may also be true that the narrative file represents an underreporting of the true frequency of ejection. There may be instances when ejection occurs, but the officer does not describe it in the narrative even though ejection is a dramatic and dangerous event. The officer may not report it because there is a persistence in some officer training even today that they are supposed to be more concerned with "first events" and "accident causes." Thus officers still may pay somewhat less attention to "during crash" events, and events related to the production or prevention of injury.

Therefore there may be situations in which ejection occurs but is not reported by the officer. It seems unlikely, however, that the opposite would be true. It seems that the officer would be rather unlikely to describe an ejection in the narrative when in fact no such ejection occurred. Despite the possibility of an across the board underreporting, the data seem likely to be appropriate for study relative changes and differences in ejection as a function of model year, vehicle type, or driver variables.

Results

For purposes of this study, accidents from the years 1971-1979 were searched. The accident files for that period included about 1.7 million passenger cars. Among that quantity, 1125 instances of ejection were recorded. This was the residual after a larger number of cases had been identified in which people fell out of the vehicle. Thus, the overall percentage of ejection was a bit less than one tenth of one percent of the vehicles. Specifically in .07 of one percent of the vehicles, one or more persons were ejected.

The frequency of ejection varied as a function of several things. For example, Table 1 shows the relative frequency of ejection as a function of the body style of the car, and shows, for example, that in two-door hardtops, .09

Table 1. Ejection frequency related to vehicle body style. North Carolina 1971-1979 accidents.

	No. Ejection Cases	% Ejection Cases (Fraction of 1%)	Total
Sedan 2 dr.	102	.09	114279
Hardtop 2 dr.	311	.07	416413
Convertible 2 dr.	26	.13	18911
Sedan 4 dr.	61	.02	247850
Van	4	.01	3949
Utility	4	.21	1861
Other	192	.05	362828
Total	696	.06	1164230

of one percent ejection occurred, whereas in four-door hardtops, it was only .02 of one percent. This is quite consistent with other literature which has traditionally shown that the four door sedan seems less subject to ejection than the two door.

It has been postulated that this is because the 4-door cars must have a stiffer B pillar due to the necessity of holding up the rear door. This in turn presents a stiffer structure resulting in less vehicle deformation in the area around the latch. The convertible is rather like the sedan. The highest ranking group is the utility vehicle which showed .21 of one percent ejection, threefold as many as for the sample as a whole. This is not surprising in terms of the configuration and use of utility vehicles.

Table 2 shows the increase in ejection risk associated with rollovers. A total of 1,386,829 vehicles were classifiable with respect to rollover (it became possible to classify a rollover beginning with 1973 data). From among that 1.38 million vehicles, 32,662 were involved in rollover which is about two and one third percent of the total. However, the two percent of vehicles which

Table 2. Ejection related to vehicle operation.
North Carolina 1973-79 accidents.

Overturn Status	Number of Eject Cases	Percent of Ejection	Total
Rollover	344	1.05	32662
No Rollover	564	.04	1354164
Total	908	.000006	1386826

overturned accounted for more than one-third of the total of 908 ejections identified during those years.

Specifically, whereas .04 of one percent of the non-rollover of vehicles were associated with ejection, 1.05 percent of the rollover accidents which is a 26-fold difference. However, as was stated earlier, one is cautioned not to assume that this means that the occurrence of rollover _per se_ increases by 26-fold the risk of being ejected. A little thought will persuade one that since rollover accidents as a group are more severe than non-rollover accidents as a group, and since ejections tend to occur more frequently in more severe crashes, then part of the difference is due to the crash severity implicit in a rollover crash.

Table 3 shows a mixed improvement for the ejection phenomena in recent years. There seems to be a general decline for ejection (using corrected figures) during the years shown, except for a curious unexpected jump upwards in 1979.

Somewhat more meaningful, however, is Table 4 which is also shown in graph form as Figure 1, which gives the frequency of ejection by model year of car. The graph shows quite clearly that back in the era during which time the cars had no interlocking door latches or had only the first generation of such

Table 4. Ejection cases by model year 1973-1979 N.C. accidents.

Model Year	No. Ejection Cases	Ejection %	Total
1950	3	.096	3119
1955	6	.177	3384
1956	7	.239	2918
1957	5	.130	3845
1958	0	.000	1876
1959	6	.111	5419
1960	9	.082	10940
1961	19	.133	14330
1962	26	.088	29725
1963	43	.094	45486
1964	58	.093	62338
1965	78	.089	87194
1966	86	.082	104558
1967	95	.089	107181
1968	85	.063	134946
1969	86	.056	152419
1970	88	.059	149468
1971	75	.051	147402
1972	98	.060	162157
1973	82	.056	147037
1974	60	.058	103297
1975	27	.047	57890
1976	32	.047	68135
1977	26	.049	53193
1978	15	.041	36795
1979	10	.066	15128
1980	0	.000	601

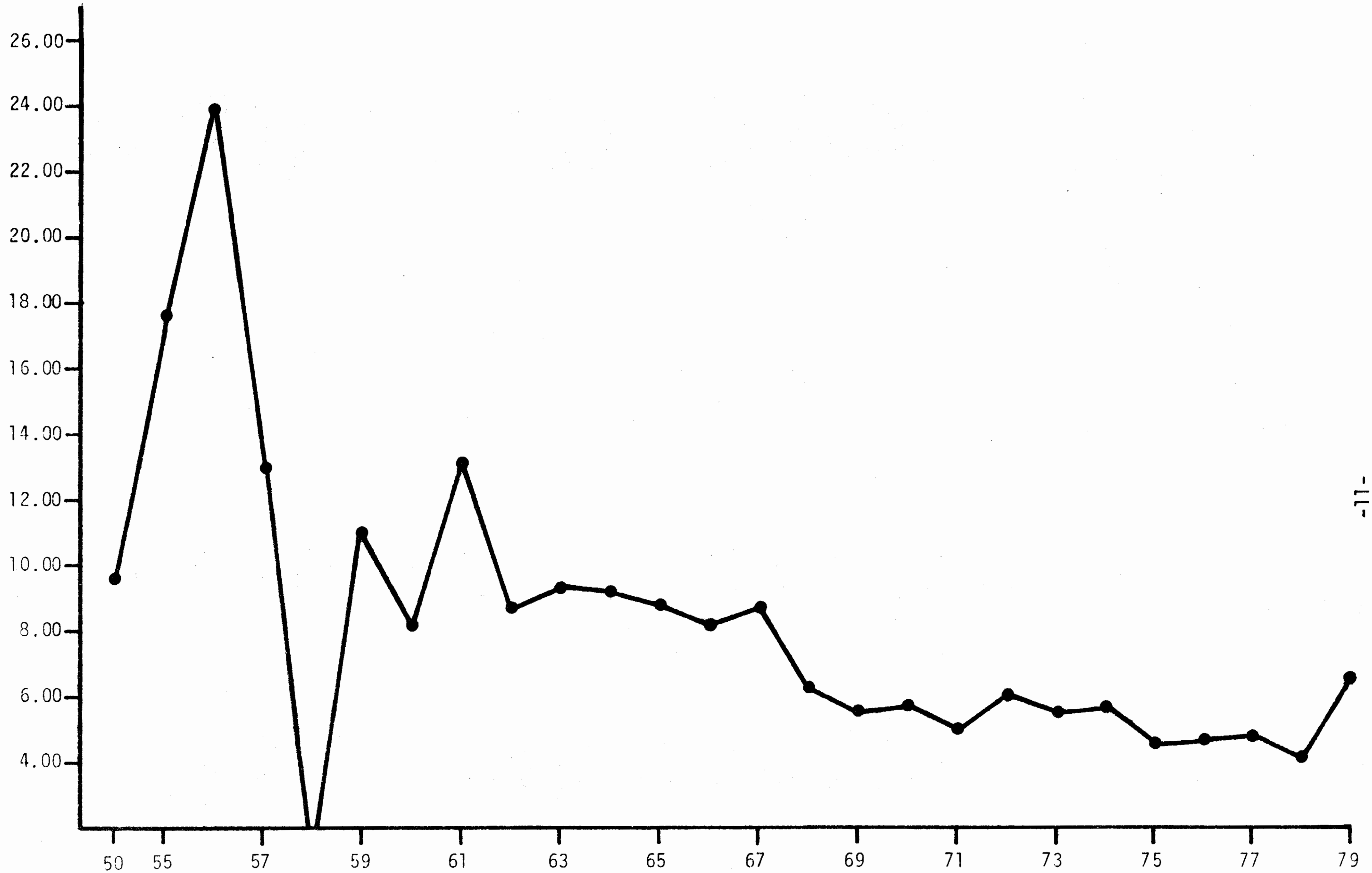

Figure 1. Ejection by car model year.

Table 3. Ejection cases by calendar year. 1973-1979 N.C. accidents.

Calendar Year	No. Ejection Cases	Eject % (fraction of 1%) Raw	Corrected*	Total
1973	163	.156	.170	104356
1974	109	.102	.137	106589
1975	131	.113	.142	116008
1976	181	.134	.146	133235
1977	138	.095	.111	144744
1978	45	.026	.078	170212
1979	130	.078	.136	166628

*Corrected for the proportion of missing narratives each year. Direct extrapolation of ejection cases to what would be expected if 100% of cases had narratives

latches, the relative frequency of ejection was much higher than it is today. For example, up through the year 1956, data show that nearly .2 of one percent of the vehicles involved someone who was ejected. That compares to a figure only about one-third to one-fourth as large during the most recent several model years. That is, a 3-fold reduction over the years.

Figure 1 also is consistent with the earlier published results which claimed that the door latches in the early 60's were superior to the ones that went before. Happily this graph also indicates that beginning with approximately 1968 models, ejection went down once more. Perhaps this suggests an even further improvement in systems to resist door openings. As a matter of fact, the data somewhat suggest three eras in the data. Although there is some jaggedness and a suggestion of a slight drop, the entire period of 1968 through 1979 models are not too far from a flat slope with a value of about .05 on the scale.

Then, the behavior of the graph from 67 models back through 62 models are not too far from a flat function at about the .09 percent level on the scale. Before that the data are unstable because of small numbers, but overall does seem to be up around .15 percent. Therefore one way of looking at the data would be to say that we have seen three improving eras in the frequency of ejection.

Figure 2 is a graph that goes into somewhat more detail. Figure 2 is a composite of four car types, drawn only from 1975 through 1977 accidents. The four car types included are two-door sedans, two-door hardtops, four-door sedans and station wagons. The model years included are only 1966-1977.

Figure 2 shows clearly the difference between ejection risk associated with rollover vs non-rollover. It shows that for these four car types, 1.1 percent of the vehicles were involved with ejection when rollover occurred, whereas the comparable ejection value is about .05 of one percent for those vehicles not involved in rollover.

Figure 3 shows information on ejection trends for two-door vs four-door sedans and shows the substantial difference between the two body styles. The four-door sedan during the more modern era seems pretty clearly to be associated with successively less frequent ejection, and has lower ejection rates than the 2 door.

In summary the above analysis shows that:

1. Narratives provide an appropriate device for studying ejection even though ejection is not a varaible that is included by check box on the accident report form.

2. During the course of the study the massive task of identifying ejection was accomplished and throughout the entire multi-year data file ejection cases were identified, and these designations have now been written on the record of the cases in question. Therefore, future analysis that needs to take ejection into account can be done much more simply.

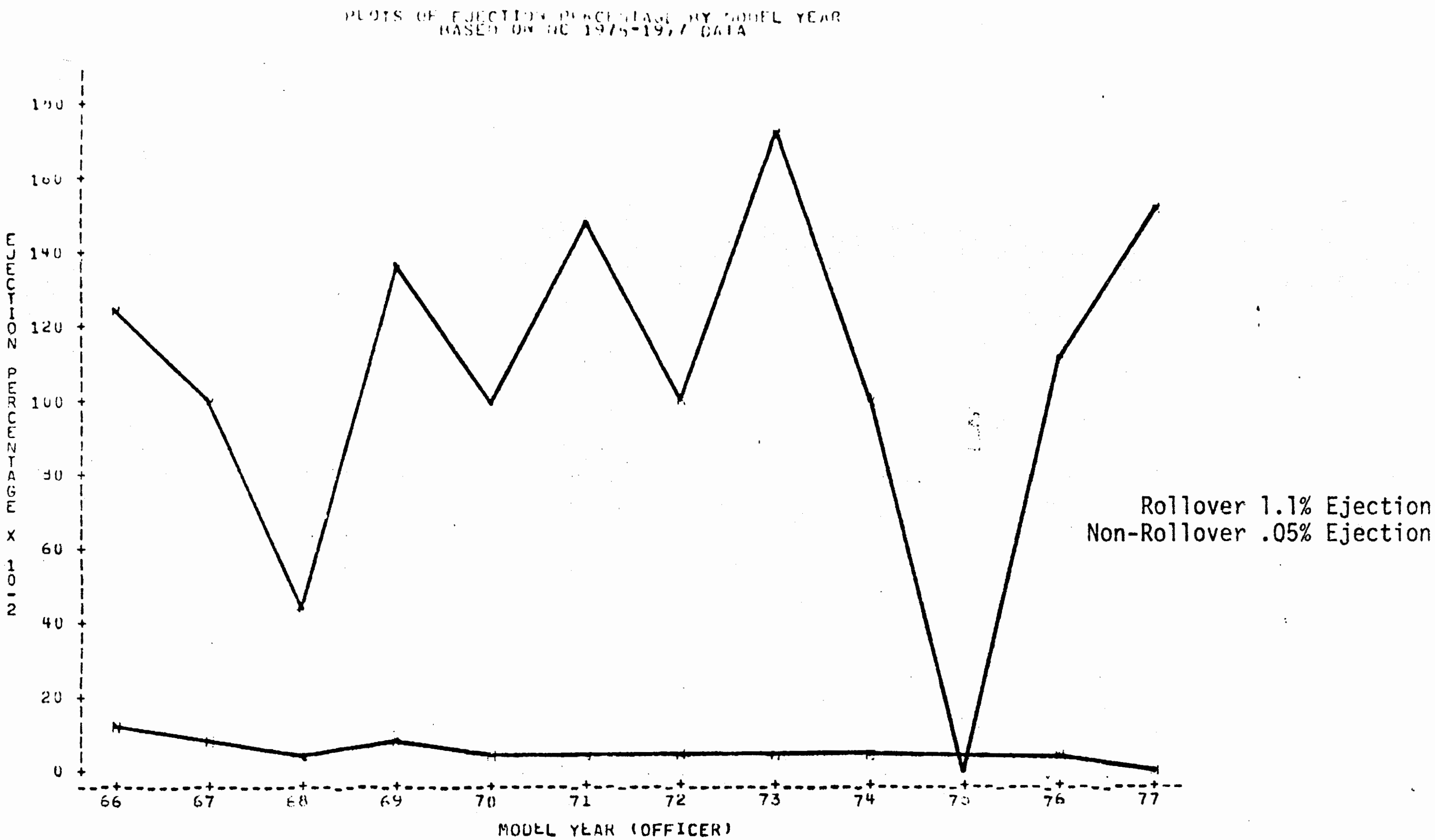

Figure 2: Rollover and Ejection for 1966-77 Models of 2 and 2-door Sedans, 2-door Hardtops, and Station Wagons.

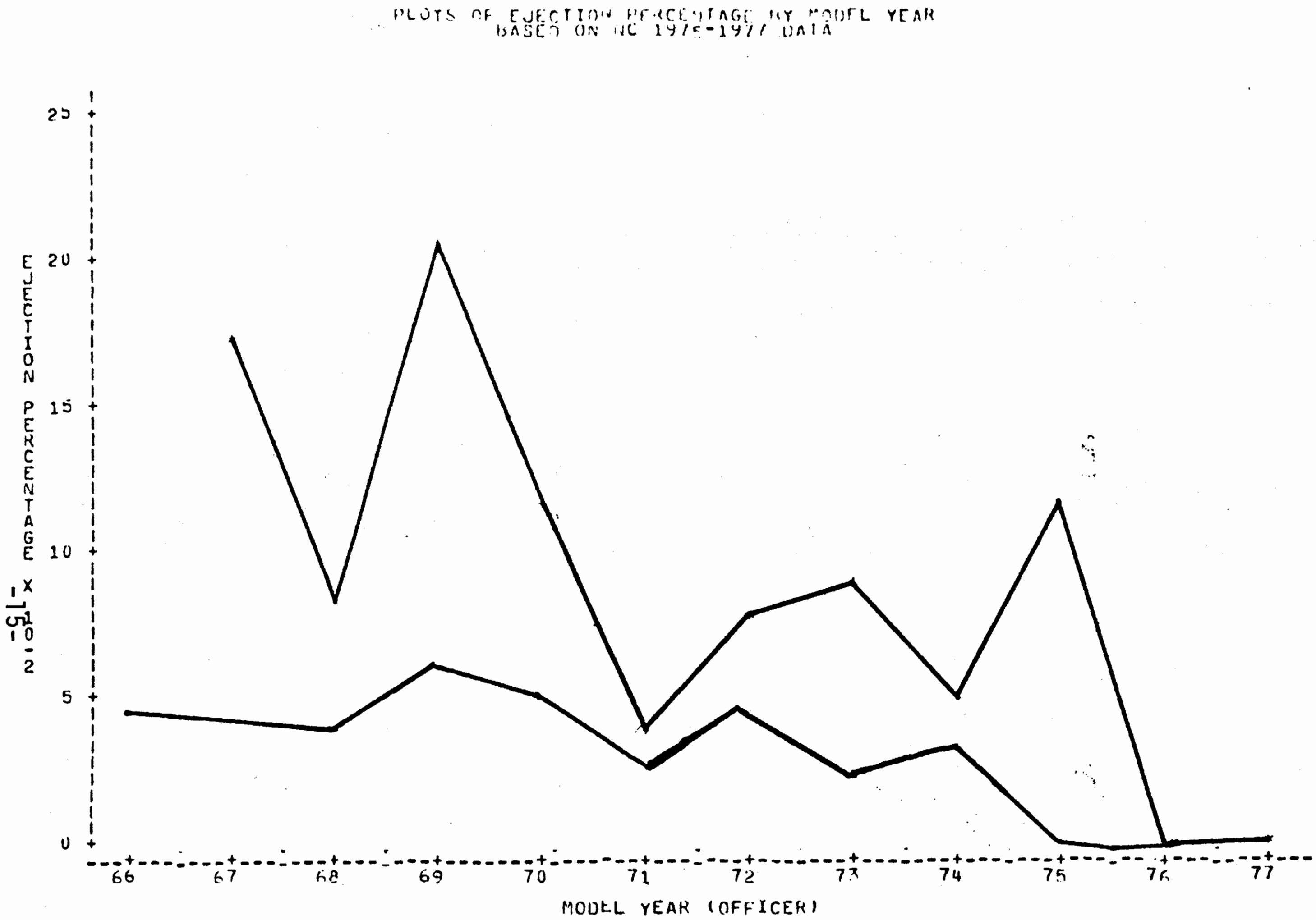

Figure 3: Ejection in 2-door vs. 4-door Cars.

3. The behavior of the ejection variable seems to be consistent with relationships that have been shown by previous ejection studies.

4. The ejection variable now coded into the data makes it possible in future studies to examine the effects of belt use on ejection, and the role of ejection related to accident type, driver age, etc.

5. A limitation that still exists is the problem of pinpointing the relative injuries to ejectees vs non-ejectees. The accident narrative is usually sufficient to identify the vehicle from which the ejection occurred, it does not necessarily help to identify which occupant was ejected. Thus, the study of ejection related to injury is limited. However, for those cars with only one occupant (a fairly large part of the total), it would be possible to look at the injuries as well.

6. In response to the NHTSA assessment of the NC accident records system, it appears that the NC narrative data system can adequately address ejection even though the data form does not contain such a check box.

THE USE OF THE ACCIDENT REPORT FORM'S COMPUTERIZED NARRATIVE DESCRIPTION TO STUDY THE CONTRIBUTION OF VEHICLE DEFECTS TO ACCIDENT OCCURRENCE

The purpose of this study is to explore and illustrate ways of using the officers narrative description for the purpose of identifying vehicle defect problems that occur with significant frequency in accidents.

Narrative description

Across the U.S. virtually every police accident report form includes, in addition to the various check boxes and blanks, a space where the officer writes a narrative description of the accident. This narrative is usually given in connection with a pictorial sketch of the crash.

Information on the narrative is used later by accident coders to help secure the necessary codes. A skillful clerk can derive significant information by reconciling the narrative description, sketch, and the various check boxes on the form. Regrettably, however, the narrative description itself is usually not stored in such a way that retrieval is feasible.

In a state the size of North Carolina about 160 thousand accidents per year are reported, each of which has a narrative. The reports are stored in filing cabinets and/or put on microfilm and therefore are usually retrievable only by pulling them out and reading them.

This is regrettable because the narrative is a particularly valuable source of information regarding those rare events not covered on the form by a check box. If one reflects on the matter, it becomes apparent when an accident report form has a prepared check box for a particular event, then, by definition, those particular events are thought by the form designers to be sufficiently frequent and of sufficient importance to warrant a check box. Equally obvious is the fact that ev ts which are much more rare than the typical accident phenomenon, or new unanticipated factors in the accident picture, are not going to have a designated a check box on the form.

One can only place a check box on the form regarding events already known to exist and be important. To detect new accident trends (or to document "old" phenomena not captured in the investigation) one needs some sort of a "early warning" system. The narrative is valuable in this respect. A trained officer, particularly one who is oriented towards this sort of thing, will often go out of his way to report relevant, unusual phenomena in the narrative itself.

North Carolina has a unique way of capturing the information contained in narratives. Since 1971 North Carolina has followed the practice of recording on computer tape the words of the narrative which the officer writes down. This means that tens of millions of officer narrative words and sentences have been captured over the years.

Merely recording these words does not, however, make them any more accesible than if they existed as "hard copy" in filing drawers or on microfilm. In conjunction with recording the words there has been a continuning program of software development by which the computer "reads" narratives rapidly and can extract, for further analysis, narratives containing a specified search word or combination of words.

In the present case the task of the analyst is to define words or phrases which an officer would use to describe a vehicle defect being present in or contributing to the accident sequence. Then these search words can be compared by the computer against an accident data subset--a test file. The complete accident narratives of all cases with "hits" can be printed out for reading by the analyst. Upon reading the narratives a judgment is made as to whether the list of search words is satisfactory, whether more words are needed, or whether some search words are bringing in too many "false alarms".

Based on these considerations the search word list is refined before performing a full scale search. Once the narratives from the complete file are extracted, the case numbers of each narrative containing a "hit" can be used to match up with the digital information on the case. Cases can then be analyzed, and cross tabulations generated.

Vehicle Defects

It is generally conceded that vehicle defects play an important, though modest sized role in the production of accidents. Although it is believed by many that human error, or lack of judgment, is a predominant cause of accidents, it has also always been true at the state and the national level that attention has been paid to vehicle defects. The obvious reason for this is that a driver would like to be able to believe that his car is reasonably free from hidden defects which could unexpectly cause a problem that might result in an accident.

Not only NHTSA, but vehicle manufacturers, state governments and the public at large have a stake in detecting and correcting vehicle defects. Unfortunately these efforts have always been plagued by lack of an adequate data system. For example, it has always been necessary for NHTSA to deal with this problem, at least as far as mass data is concerned, through customer complaint files. These are not accident files; they are severely biased, and could even be deliberately manipulated externally. Certain groups forward large numbers of complaint letters to this file and NHTSA presumably must accept tham, having no way of knowing whether the forwarding groups have been selective in what they might forward.

It is extremely important to have a large data file which can be directed toward the problem of vehicle defects. This is important to North Carolina because our citizens are at risk in these cars, and it is important that significant defects be detected, that corrective action be taken, and that the public be kept aware.

It is also important from an economic standpoint that North Carolina citizens not be asked to bear the economic burden of "correcting" vehicle defects which really do not even exist (which could happen if manufacturers spend large amounts of money dealing with vehicle "problems" which do not, in fact, exist).

The difficulty in trying to use accident data for examination of vehicle defects stems from the fact that there is a large number of vehicle defects that can occur. Almost every mechanical failure one can think of, can occur in a crash. However, each category by itself occurs rarely. Even in a category as large as tire defects, there are many different subcategories that make up the total including blowouts, slick tires, tires coming off the rim, etc. With respect to car structural failures there are things like a breaking axle, tie-rod, balljoint, wheel coming off, etc.

Naturally, since there are so many categories of vehicle problems that can occur, it is quite impossible to devote the necessary amount of space on an accident report form to providing check boxes or blanks to be filled in for each and every type of vehicle defect. Further, even if a police agency were to decide to devote the necessary check box to every known vehicle defect, the form would soon be obsolete for the simple reason that new classes of vehicle defects are being uncovered all the time.

New vehicle defect categories emerge as new cars come onto the market. Therefore, a system is needed that can address vehicle defects preferably without the necessity of redesigning a form every time a new defect crops up.

Even if one could design a form, by definition, one is a good deal too late if one has (1) become aware that a given vehicle defect exists (2) now wants some data and (3) designs a form to collect the data. Clearly, the problem has already been in effect a long time.

This is one of the two reasons why the NASS data system cannot effectively be used in the area of vehicle defects. First, because it will always lag too far behind the problem, and second, because the size of the accident data input, amounting to only 20,000 cases per year is quite inadequate for the low probability level of the defects in question.

Procedure

The purpose of this substudy is to determine the degree of correspondence between the frequency with which police officers mention a defect in the accident report narrative description vs. the frequency with which he checks the the appropriate vehicle defects checkbox. Thus, on the accident report form there is a checkbox for a few, presumably important vehicle defects. (The computer tape equivalent of this checkbox is variable 36, column 58). The officer can mark one of eight responses. Shown below are the number of vehicles for which each box was checked in 1979.

1)	defective brakes	4084
2)	defective headlights	168
3)	defective rearlights	763
4)	defective steering	642
5)	defective tires	4181
6)	other defects	1420
7)	no defect detected	
8)	not stated	

Total Accidents 176, 633 (1979)

Total Vehicles in those Accidents 319, 357

Therefore an illustrative question for study is to select out those accidents in which, for example, defective steering is checked. For the record, it is found that for about 2/10 of one percent of the crashed vehicles (one out of every 500) the officer checks the steering defect category. A point of interest is to determine the correspondence between the presence or absence of a check in that box vs some reference or lack of reference to a steering defect in the narrative. Four situations could arise:

1) no check box indicated, and no narrative reference
2) steering check box indicated, no narrative reference
3) steering check box not indicated, narrative reference present
4) steering check box and narrative both positive

It is obvious that categories two and three are those in which the officer refers to a steering defect in one case but not the other. The best picture of the overall frequency of steering defects would be the sum of the checkbox plus the narrative.

This is a matter of officer procedure at the accident scene. Some officers may operate under the assumption that if the steering is defective and they check the appropriate box, then they have no obligation to delineate the vehicle defect in the narrative. They may feel that some other aspects of the accidents are more important to describe in the narrative, or the officer may feel that if he describes the steering failure in the narrative, then there is no reason also to check the box. When cases were examined it was found in fact that officers sometimes report a steering defect in one location but not the other.

The procedures were as follows.

Step 1 was to scan 1979 NC accident data and select out only those accidents in which the officer indicated by checkbox that a steering defect was present. From among 319,357 vehicles the officer checked the steering defect box 642 times, 0.2 of one percent.

Step 2 is to print out available narratives for all such accidents. Narratives were available for 364 of the 642 crash vehicles. In 1979, narratives could be prepared for only about 60% of the accidents that year because of work load problems of switching over to the new accident form.

Step 3 is to read those narratives and to determine in what percentage there was reference to a steering defect.

By doing this, we can examine the degree to which the officer checks the box and also mentions the steering problem in the narrative. However, this step does not address the possibility that the officer may sometimes refer to steering defects in the narrative, but not by use of the checkbox. Therefore;

Step 4 is to make a list of the words and terms the officers used to describe the steering defect in Step 3.

Step 5 is then to search the rest of the accident file for those same words. That is, the steering defect search words turned up in Step 3 are placed in the computer and searched against the 99.8 percent of the accident file in which the officer did not use the checkbox to indicate a steering defect.

With that output we can ascertain the extent to which officers refer to steering defects in the narrative but make no use of the checkbox. Obviously, then the sum of the results from Steps 3 and 4 would constitute the maximum number of instances in which the steering defect is detectable from the data.

Step 6 is to derive a scheme by which a minimum number of search words are defined that will detect the maximum number of steering defect situations and yet capture the minimum number of false alarms.

To whatever extent this process is successful opens the possibility of having the computer, in the future, economically code as a steering defect the narratives in which the prescribed search words appear. This would be a time saver in that some preliminary coding could be done by the computer on a routine basis. At such time as a formal study were undertaken, certain narratives would be read to sift out the "false alarms".

Similar procedures were carried out for each of the five defects above. For those defects which occurred in modest numbers, all narratives were examined. For the large category like tire defects only a ten percent sample of narratives was read.

The most interesting defect category of all, the one containing a large number of different kinds of vehicle problems, is the "other" defects category. For this purpose a second study was done in which we had computer print out all the accident narratives in which the officer coded the "other" defect category. There were about 850 of these cases. We then read each of these narratives and found that indeed in most instances the officer did describe the nature of the defect. Presumably, the officer realized that when he checked the "other" defect box there was some necessity for him to mention it in the narrative, so that the reader would know the nature of the defect.

However, in reading these 850 cases we found <u>many</u> different categories of defects. The first problem therefore was to read the narratives and try to classify the defect cases into a manageable number of categories. Several categories were ultimately defined.

The final and most difficult step came after we reduced the 800+ cases down to a manageable number of 13 categories. We found initially that a rather large number of search words were needed to channel the 800+ cases into the 13 categories. In some instances, it was necessary to use 35 or 40 different words, because officers used such diverse language to describe the phenomena in a single category.

The next step then was to go through this very extensive list of search words and come up with a reduced number of search words which would have the maximum utility in picking out the "good" cases while holding to a minimum number of "false alarm" cases also brought in. Once this list was finally refined, the list (still rather extensive) was read against the "rest" of the file to see what additional cases would be brought in.

Results - Steering Defect

For the purposes of steering defect analysis, 1979 data were scanned. This included 165,700 accidents which involved 319,357 vehicles. Among that number of vehicles the officer checked the checkbox for a steering defect in 642 cases. That is 0.2 of one percent of the vehicles.

The first step was to read as many narratives as were available for those particular checkboxes. Unfortunately, only 364 narratives were available (57 percent). The reason for this diminished number is that 1979 was the year in which the new accident report form was introduced. Therefore a vast new coding procedure was also introduced. For that reason, it was not possible for the Department of Motor Vehicles that year in view of work load problems to code all narratives while they were switching over to the new system.

Accordingly, only 58 percent of the available accidents were coded for narratives that particular year. This amounted to 96,527 narratives. In a typical year, however, nearly 100 percent would be coded. The 364 narratives were printed out by the computer and all of them were read.

In 142 of the 364 or 39 percent, there was a clear mention of a steering problem in the narrative. An example of a case in which the officer not only checked the box but also mentioned that the steering defective was case 81806:

"Vehicle 1 travelling north at a slow rate of speed. Vehicle 2 following Vehicle 1. Vehicle 2 started at attempt to pass Vehicle 1 when he swerved into the left rear of Vehicle 1. The steering of vehicle 2 was very much defective."

There are other instances in which the officer makes no mention of steering even though he checked the box. Case #83820:

"I lost control in curve to prevent head-on collision. Left roadway on left and struck 2 parked in yard."

Here was an instance in which the officer felt sufficiently confident that a steering defect problem existed that he checked the check box. However, he made no mention of this situation in the narrative report.

Once having read through this group of narratives, the next task was to write down all the different words and phraseology the officers had used in capturing the 142 cases in question. Even though there were only 142 cases, there was quite a large listing of words the officers used. This is shown:

"upstream of steering"		"downstream of steering"
improper	steering	went down
lost		came loose
faulty		problem
failure of		malfunctioned
		failed
		locked
		defect
		out of order
		broke
		break
		broken
		collapsed
		came off
		stuck
		hung up
		not working
		control

As you can see reporting officers used several words preceding the word "steering" to describe the situation, and also many words following the word steering. Thus, some of the narratives mention the words, "improper steering," "steering went out," or "steering malfunctioned," or "steering wheel collapsed."

Howev..., we were very fortunate in this situation in that one word turns out to be common to every one of the cases -- the word "steering." Fortunately, when the officer did refer to a steering defect, he used precisely the word, "steering." He may have used other words before and after it, but the one simple common denominator was "steering." This meant that the search parameter was very simple.

The next step was to search the narratives of the accident reports where the officer did not check the steering defect box. Of course, this is the very large majority of all accidents (99.8% in fact).

A small sample of test data was searched using the word, "steering" and a number of "good cases" came out--cases where the word "steering" appears in the narrative and sure enough, when read, the narrative refers to a steering defect. Unfortunately, simply using the word, "steering" also brought in another class of accidents which did not involve a steering defect, but which involved going to sleep at the steering wheel.

Those are situations in which the officer would say that the "driver went to sleep at the steering wheel" or "fell asleep and lost steering control." In the second and final iteration, all narratives were searched in which the word, "steering" appeared, but if there was the word "sleep" or "asleep" upstream of the word "steering," (i.e., appearing earlier in the narrative than the word "steering) then this was suppressed. That process only suppressed five cases in the case of "sleep," and 11 other cases of the word "asleep."

When the rest of the accident file was searched, 452 additonal cases came in with the word, "steering." However, this still proved to be fairly inefficient because only 102 out of the 452, or less than one quarter turned out to be bona fide cases.

Neverth less by virtue of the narrative, 102 additional cases were captured. Bear in mind this number is with only 58 percent of the narratives available. Extrapolating to a 100 percent availability of narratives, we estimate that 175 additional steering cases would have been captured. Therefore, by using the check box in combination with the narrative situation, the 642 steering defects previously mentioned would have been expanded by 175 additional cases. This would be a 27 percent increase which could bring the total up to 817 steering defect cases captured in this way.

Obviously, further refinement can be undertaken in which other suppressed words can be used to eliminate some of the "false alarms" that came in with the word "steering." See Table 1.

Table 1: Search words and number of "Hits" relative to steering defects.

Search Words first position	STEERING DEFECTS second position	CASES PICKED UP
STEER		452
	SUPPRESSION VARIABLES	
SLEEP	STEER	5
ASLEE	STEER	11

Headlights

For the vehicle defect category of headlights, the check box was indicated in 168 instances out of the 165,700 accidents or almost exactly 1 in 1000 times. In this particular instance, 106 (of 168) narratives were available (64 percent).

Of the 106 narratives, 35 instances were found in which the officer mentioned the defective headlight. Bear in mind that he had checked the box in all 106 of these cases, but he did not mention headlights in most of the narratives. An illustrative case would be #71410:

> "Vehicle 1 was traveling west and driver stated her lights went out at the intersection and she could not see. 1 then hit the yard. Witnesses stated vehicle 1's lights went out and they stopped to see if the driver was hurt."

In the 35 "hit" cases, quite a few hit words and phrases came up consisting of various combinations below.

without	headlights	went out
no	lights	go out
did not have	head lamps	gone out
not equipped	dimmer switch	going out
	lighting	went off
		was not operating
		was out
		started flashing

It can be seen that there are quite a few words and phrases used, but it was possible to search with relatively few words. The results of searching the rest of the data, the large part of the file when the officer did not check the headlight defect box, produced the following "hits" (based on the following word combinations:

Lights went out	-	5 cases
Headlights out	-	8
Headlights defective	-	9
Headlights not	-	4
No lights	-	126
Head light	-	64
Did not lights	-	131

It was also found necessary to suppress several other terms. For example, we suppressed anything that said "traffic lights" and that resulted in suppressing 36 cases. Also many times the officer mentioned headlights in context of a driver being blinded by oncoming headlights. Therefore we suppressed the word "headlight" when it was preceded by "blind" and that knocked out 48 cases. We also suppressed "headlights" when it was followed by the word "blind" and that knocked out an additional 13 cases. See Table 2.

However, of this total number of apparent hit cases, namely 347 additonal narratives, many of them did not in fact refer to defective headlights when these cases were read.

Table 2: Search words and number of "hits" relative to headlight subjects.

HEADLIGHT DEFECTS

Search Words		Cases Picked Up
First position	Second position	
Lights	went out	5
Headlights	out	8
	off	9
	not	4
No	lights	126 (several false alarms)
Head	Light	64
Did not	Lights	131 (several false alarms)

Suppression Variables

Blind	Headlights	36 suppressed
Headlight	Blind	13
Traffic	Lights	36

With respect to tires, shown in Table 3, a considerable number of search words were also indicated. "Tires" was an interesting category in that the officer most rarely of all mentioned anything about what was the nature of the problem with the tire when he checked that check box. In less than 10 percent of the narratives we checked did the officer mention anything about tires, despite the fact that he had checked the timeer defect box. In other words, we read 311 narratives from cases in which the officer checked the tire defect box, but in only 27 narratives did he mention this problem.

However the interesting thing is that when he did mention it, the word "blowout" was the word that figured most prominently. This makes one wonder whether the officer has a higher tendency to mention blowouts, and whether therefore in a great percentage of the cases where he made no specific mention in the narrative there were no blowouts.

Table 3: Search words and number of "Hits" relative to headlight defects.

TIRE DEFECTS

Search Words		Cases Picked Up
First position	second position	
Tire	Blow	35
	Blew	207
	Air	2
	Flat	45
	Slick	8
Flat	Tire	45
Blow	Tire	21
Wheel	Came off	30
	Lock	39
Lost	Wheel	122- (most of which not applicable)

By far the most difficult and yet the most interesting of the categories were the narratives which resulted from the category, "Other Defects." There were 1420 accidents in which the officer checked the box, "other defect." It is of some interest to notice the size of this category. As is shown in Table 4, the only two defect categories that are larger are the brake category and the tire category, each with over 4,000 vehicles involved. The headlights, rear lights and steering category combined scarcely matched the number of instances in which the officer checked, "other defect."

Table 4: Comparison of number of accidents and vehicles in digital defect record with number of narratives available.

VEHICLE DEFECTS 1979

Defect	#Vehicles	#Narratives	#Accidents
1. Brakes	4084	2328	3841
2. Headlights	168	106	166
3. Rear lights	763	481	755
4. Steering	642	364	630
5. Tires	4181	2503	4130
6. Other	1420	843	1411

The large number of categories that were covered in the "other" defect category was truly startling. Just to give some idea of the diversity, listed below are the several categories into which we felt we could conveniently and meaningfully combined these 843 cases. The process of arriving at 13 categories was itself rather involved. Hundreds of cases were read, placed in a large number of different categories. Gradually, we tried to combine and collapse categories down to a manageable number.

Category 1: Fire, including smelling smoke, engine burning, smoke, electrical fires from under the dash.

Category 2: Transmission problems, including a considerable number of cars jumping into gear, jumping out of gear, moving from park to reverse etc. This also included references to damaged gear boxes, the gear breaking, the clutch giving away, the throttle breaking, etc.

Category 3: Engine problems including engine backfiring, stalling, being unable to crank, engine quitting, accelerating, dying, cutting off, etc.

Category 4: Door coming open including the latch being defective or the door coming off.

Category 5: Battery problems including accidents when the car was being jump started, or people being alongside the road with a disabled car, or trying to start the car.

Category 6: No lights or flashers or turn signals broken: It's interesting that the officers used the "other" defects category in a good many instances here rather than the rear lights check box. Perhaps problems with the signal lights or warning flashers are regarded as sufficiently different from the rear lights to warrant using the "other" category.

Category 7 includes a number of cases in which a car was stalled or abandoned in the roadway.

Category 8: Wheels and rims. Here it is not so much that the tires went flat but that they came off the car. There were many references to the wheel, tire, rim, lug bolt, or lug nuts "coming off" or "running off" or "breaking off" separated from the car.

Category 9: Windshield obstructions resulting in vision impairment.

Category 10: Windshield wipers including instances in which officers referred to the fact that wipers were not working or had been sticking or had quit.

Category 11: There were a number of cases in which a mechanical failure underneath the car occurred. This includes situations in which the officer referred to breaking, coming loose or falling off of things like the drive shaft, ball joint, tie rod, steering rod, frame, axle, springs, drive shaft, shock absorbers, spring hangers, etc.

Category 12: There was a significant number of accelerator pedals sticking which would result in a racing engine.

Category 13: Towing including a considerable number of cases in which some problem developed with a towed vehicle such that it broke free, a hitch came apart, chain broke, hitch and trailer became disengaged, or pulled loose.

For illustration, below are several cases in which the narratives are presented to illustrate a few of the above situations.

Case 5714 - Vehicle 3 had pulled up and attempted to jump off the battery when Vehicle 1 collided.

Case 6072 - Vehicle 2 was parked off the highway on the westbound shoulder. Vehicle 1 traveling west on RP 1343. The tie rod on vehicle 1's vehicle came loose and vehicle 1 ran off the right side of the road and struck vehicle 2.

Case 9434 - Vehicle 1 was parked in a travel lane gave out of gas, when vehicle 2 struck the rear of Vehicle 1.

Case 11212 - Vehicle 3 was disabled when the left front wheel came off of vehicle 1 and struck vehicle 3.

Case 11608 - Vehicle 1 was traveling west on North Carolina 98 and lost control when part of the A-frame broke, ran off the right and collided with a ditch bank.

Case 11626 - Vehicle 1 was proceeding west on rural unpaved 1504 and as her speed increased, she lost control of her vehicle and skidded off the roadway on the right and struck a mailbox and continued on for approximately six feet and struck a large oak tree. Driver stated that gas pedal stuck.

Case 14108 - Vehicle 2 was parked in a private drive. Vehicle 2 jumped out of gear and rolled down into U.S. 220 and struck vehicle 1.

Case 14440 - Two left tires on Chevrolet truck came off rims and rolled west on Highway 70. One tire struck eastbound Buick who was trying to avoid it; second tire struck Olds that was turning south into Holiday Inn driveway.

Case 23881 - Vehicle 1 was traveling north on U.S. 301. Vehicle 2 was traveling in a U-haul truck towing a VW. The VW broke loose, forced 1 off the road, continued on and struck the Cumberland County Auditorium.

It is seen that the few specific categories for which checkboxes are provided seem to cover a good many of the instances in which, for example tire, defects were detected. However, it does not cover the very large number of instances for the other defects.

For example, with respect to brakes, whereas there were about 4000 checkboxes, the use of the narratives seemed to expand that category by less than 1000. With respect to tires which again is about 4000, the narratives again seemed to expand that category by a few hundred. Thus, it would appear that in the instances where the check box is provided on the form, the presence of the narrative adds a significant number of additional cases does, but not an overwhelming number.

However, the large "Other" Defects category is the place where the narrative proves invaluable by defining many new categories that would not otherwise be found. The overall number of "other" defects was roughly doubled by the use of the narrative, and even more important, their nature was discovered.

Below is a list of preliminary "hit" words that have been derived through this exercise. Alongside is the number of "hits" in 1979.

Brake	5763	
Headlamp	11	
Headlight	119	
Lights	636	
Flasher	73	
Tur* Indicat	20	
Steer	357	
Wheel	1090	mostly not applicable

Tire	876	
Door	679	
Battery	10	
Fire	440	
Gear	153	
Clutch	43	
Throttle	2	
Lug	6	
Signal	2320	
Tur* Sign	1687	
Shaft	5	
Ball* Join	2	
Tie(Rod	3	
Transm	21	
Ax	21	
Spring	133	mostly Spring St.
Springs	31	" ... Springs Rd.
Shock	5	
Gas	405	mostly not applicable
Accel	274	
Gaso	16	
Tow	68	
Towing	175, 185	
Trail	657, 768	
Tractor	472	
Bolt	19	
Chain	194	
Hitch	24	
Winds...hield	291	
Window	207	
Vision	558	many not applicable
Wipers	18	

Plans for the Future

One of the long range possibilities growing out of this analysis is the use of the computer on a routine basis to do some preliminary defect coding prior to intervention by an analyst. We are looking into the possibility of setting up computer software to process each incoming case as we receive it from Raleigh. Cases will be processed against an elaborate set of word and phrase requirements. If certain words and phrases are present a provisional code will be made labeling that accident as having involved such and such a defect category.

This will only be a provisional coding, however. At such time as a formal study is done, some cases with that provisional code will be examined, and the study will proceed on the basis of an examination. Part of the further study in this area is whether the program can be made sophisticated enough to warrant not reading the cases at all.

The advantage of having the computer do this preliminary coding and screening is to give some preliminary indication of the quantities of data that fall in the various categories.

Obviously, this approach is not limited to vehicle defects, but is applicable to various driver events of significance which can be reflected in the narratives but which do not have a corresponding check box on the form. Vehicle defects are in fact only one tiny segment of the possibilities for use.

AN ANALYSIS OF REPORTED TIRE DEFECTS IN NORTH CAROLINA ACCIDENTS

Introduction

The North Carolina accident report form includes a space where the reporting police officer at the crash scene can indicate the presence of one or more vehicle defects. He can also describe the vehicle defect using the narrative section of the form, and in training he is encouraged to do this. Vehicle defects are indicated for about four percent of crash involved vehicles.

One of the more common vehicle defects indicated by officers is tires. Based on the officer's narrative description, when he checks the tire defect box, he may be talking about any of several situations such as a blowout, slick tires, worn tires, tires coming off the rim, etc.

For the purposes of this analysis, four calendar years of N.C. accident data were included--1977, 1978, 1979, and 1980. From among the nearly one million crash involved vehicles in those four years of accidents, the analysis was confined to passenger cars of model years 1974-79. Further, the analysis was confined to those particular passenger cars with sufficiently accurate VIN information to permit dividing them into the following car groups:

1. Large cars
2. Intermediate cars
3. Compacts
4. Subcompacts
5. Foreign imports

Of the passenger cars that met these definitions, 2084 were vehicles with an officer reported tire defect. That number was from among a total of 278,067 vehicles. This means that for approximately three-quarters of one percent of the vehicles the officer indicated a tire defect.

Following is a series of graphs which describe some of the characteristics associated with vehicles in which a tire defect is reported.

Figure 1 shows the overall percentage of tire defects for each of the four calendar years involved. It is seen, for example, that for calendar year 1977 approximately .65 of one percent of the vehicles were reported with a tire defect whereas for 1980, the value was approximately .83 of one percent.*

Thus, there is a slight but seemingly rather steady increase over the four years in the frequency with which tire defects are reported to be present in accident involved passenger cars.

This in itself is rather unexpected and suggests that other factors may also be operating. This is because it is known, in general, that tires have been improving in recent years as the conversion is made from bias belted tires to radial tires. In general, radial tires have been performing better than earlier tires. Assuming that is true, one might expect that the percentage of tire defects would <u>decrease</u> over the four years, but in fact it has increased. Therefore, one needs to be alert to the possibility that other factors may be operating, which have produced what might be an unexpected trend.

Another way of looking at the data is shown in Figure 2 in which the percentage of tire defects is reported by car model year. Here, a steady <u>improvement</u> is seen with more recent cars having fewer defects. In fact, the rate goes down nearly three-fold in just the six model years involved. For 1974 models, tire defects were reported in more than 1.2 percent of the cars. This falls rather steadily tq about 0.4% for 1979 models. Thus, there seems to be something of a contradiction between Figures 1 and 2. With the newer car models showing steady improvement, one might therefore have expected Figure 1 also to show a downward trend since newer models (with their better record according to Figure 2) are naturally more heavily represented in 1980 accidents than they were in 1977 accidents. Thus, one is confronted with an apparent contradiction.

---

*A series of appendix tables are included which, when combined appropriately provide the frequency tables on which all figures herein are based.

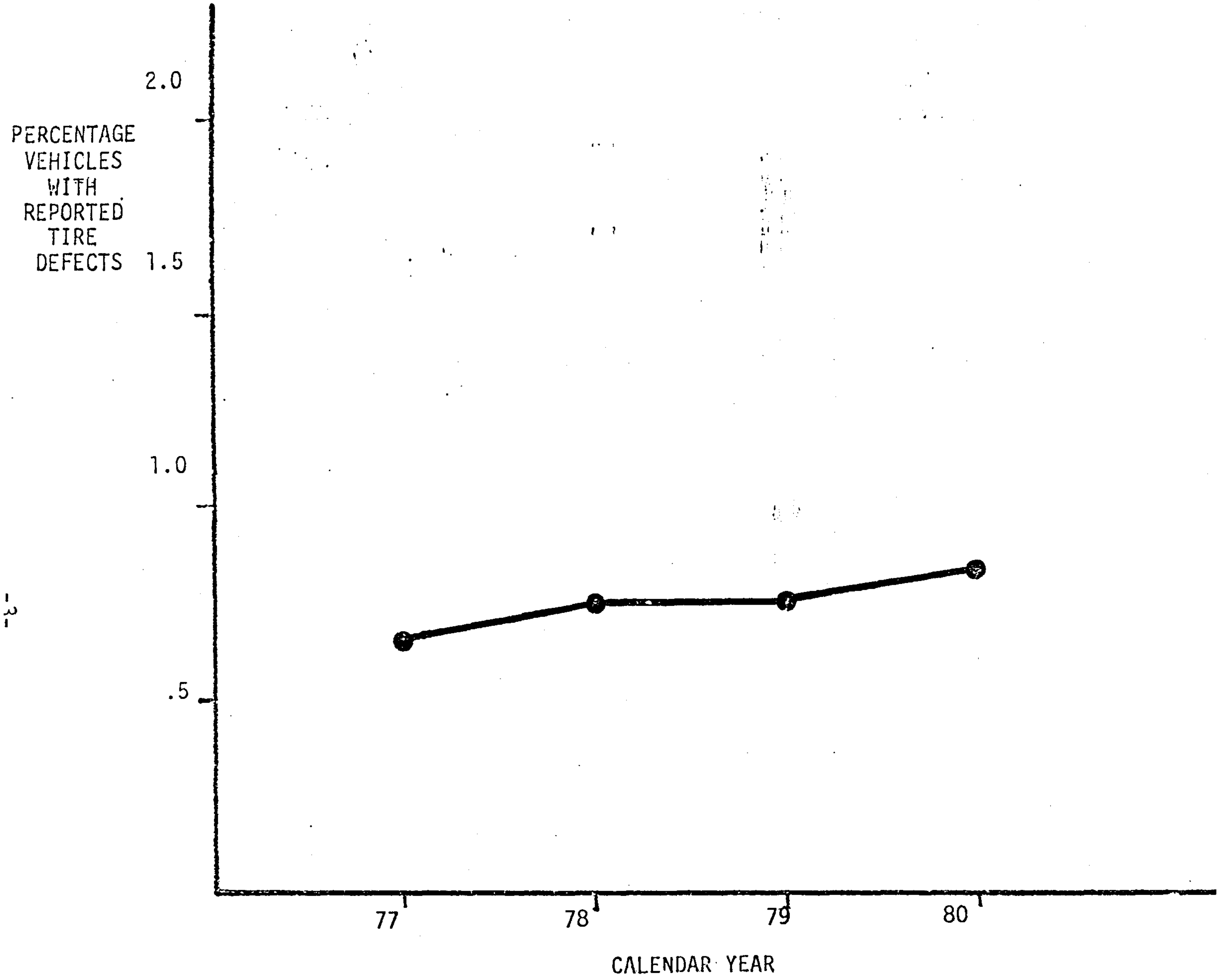

Figure 1. Percent tire defects by calendar year.

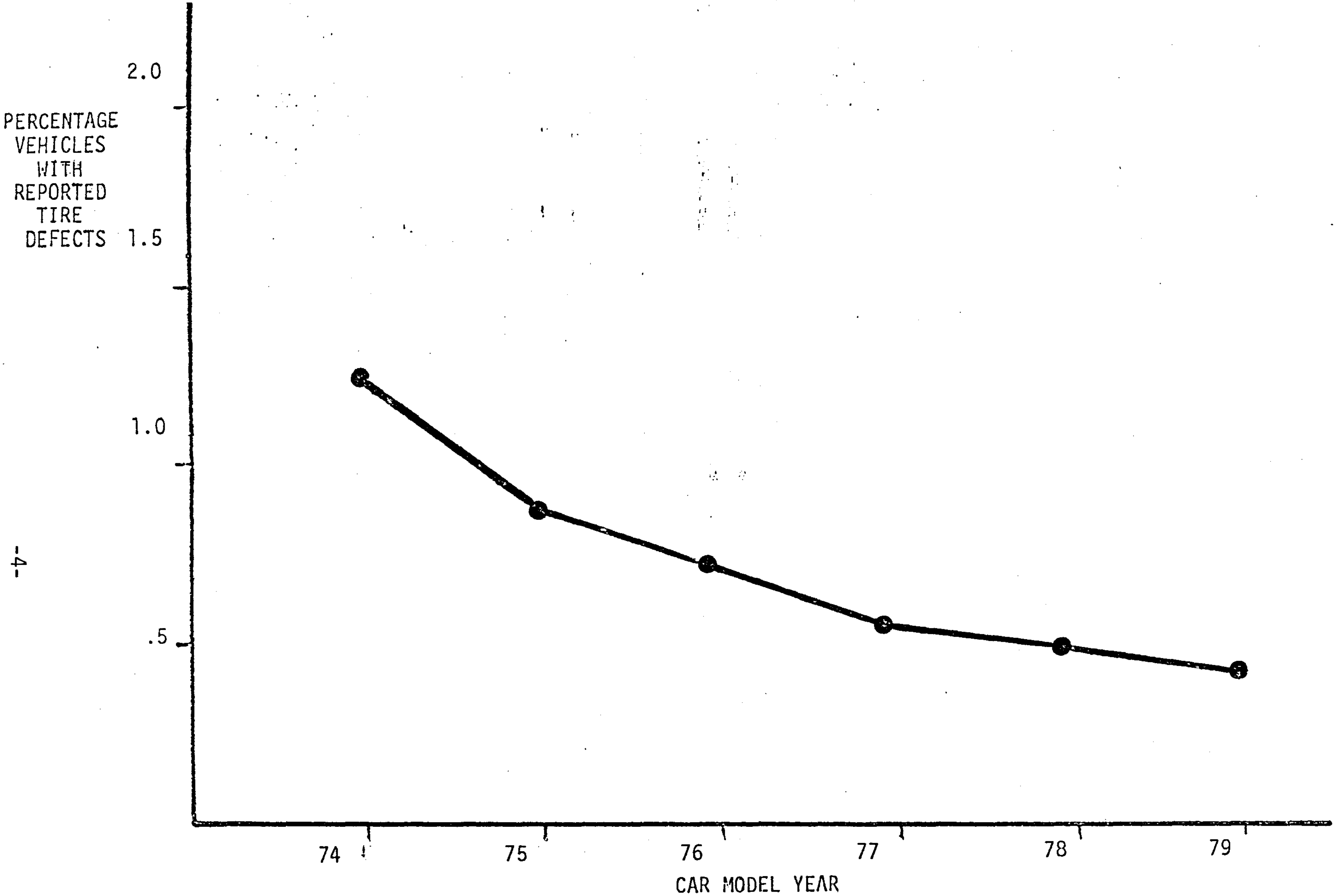

Figure 2. Percent tire defects related to car model year.

However, from other research it is known that still other factors are operating. Even though tire improvements presumably are successively more heavily reflected during the period from 1977 to 1980, it is also true that the relative proportion of small cars in the population was increasing rapidly during the same years. From other research, one is led to consider the role of the small cars to learn whether for some reason tire defects are relatively more frequent in small cars. The very act of considering the relevance of a car size variable in turn raises the question of another variable---driver age. Driver age becomes an issue because it is known that the average age of the drivers is not the same for all different sizes of cars.

Figure 3 is a somewhat more straightforward way of considering tire defects as cars get older. Figure 3 shows the percentage of tire defects according to how many years old the car is. A zero year old car is a current model car and the graph shows the range from zero to six years old.

This particular graph requires a bit of explanation because it reflects several different model years. Data for the zero model year includes 1977 models involved in accidents during 1977, plus 1978 model cars involved in 1978 accidents, and 1979 model cars involved in 1979. Thus, three different model years make up the zero years old category. The requirement is that those particular models were crash-involved during the first year since they were produced.

By the same token, several different model years make up the "one year old" group, namely, '76 models in '77 accidents; '77 models in '78 accidents, '78 models in '79 accidents and '79 models in '80 accidents. A little thought will show the reader that there are several combinations of model years and accident years that can contribute to a given part of the graph. When one considers the six year old cars, however, there is only one combination available and that is '74 car models that were involved in accidents during 1980.

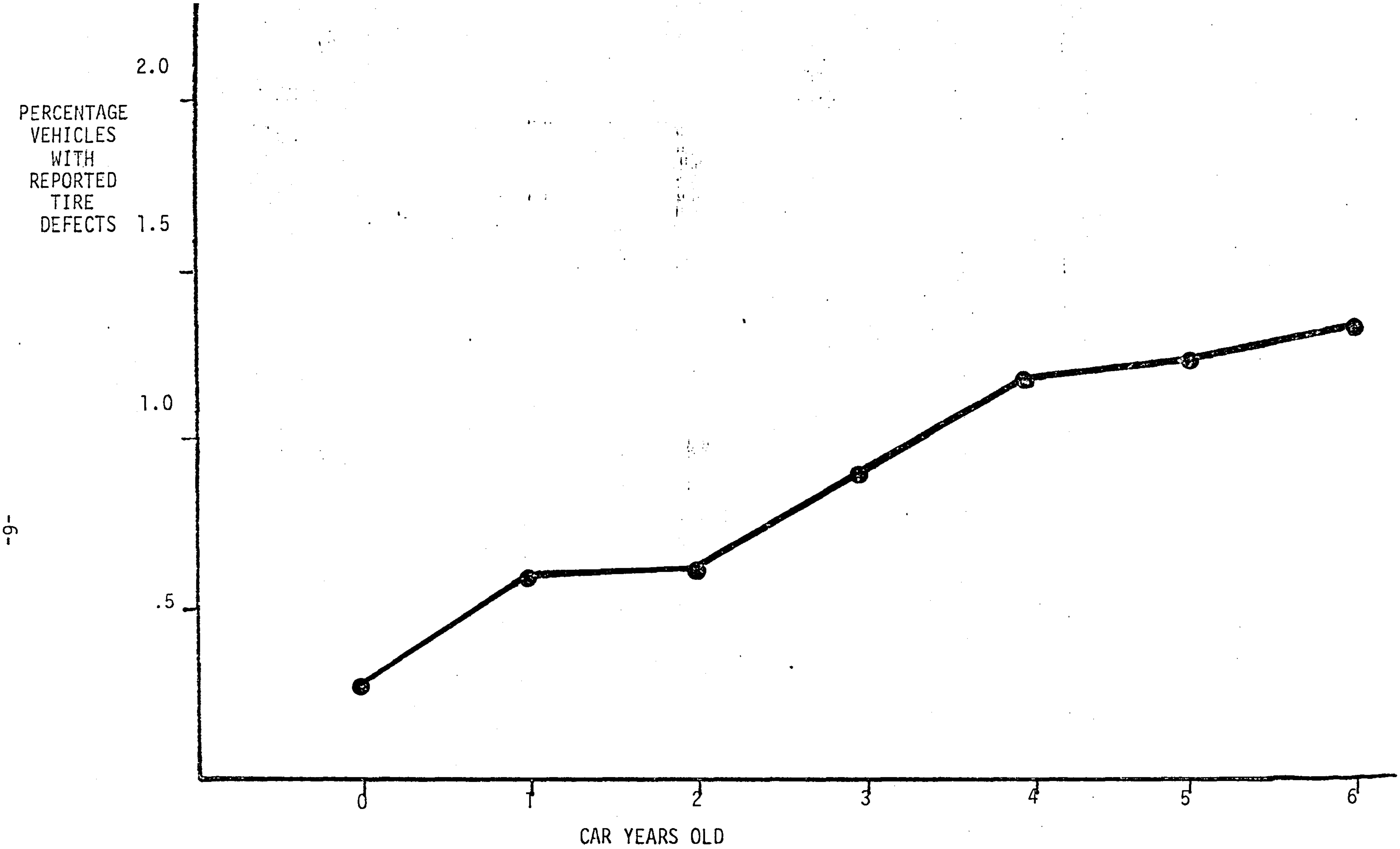

Figure 3. Percent tire defects related to car age.

To repeat, the study is limited to accidents that occurred during 1977-1980 and is confined to 1974 through 1979 car model years. To review, the first three graphs show three distinct trends. One shows, as expected, that the percentage of tire defect increases in rather an orderly way as the car gets older. Second, it is seen that the tire defect experience is more favorable for later model year cars rather than earlier model year cars. Third, the average level of tire defect increased slightly during the calendar year period, 1977-1980.

The next series of graphs is somewhat more complicated since they consider driver age and vehicle size as well as car age and tire defects. It seems a reasonable hypothesis that driver age may be related to the experience of the car with respect to tire defects. First, patterns of driving seem to differ by age. This may in turn influence the frequency with which tire defects or failures occur. Second, there is the general trend in our society that the economic power or affluence of older people is usually greater than that of younger people. Degree of affluence in turn can have simultaneous implications for the "newness" of the car that is owned, its size, how well it is maintained, and the likelihood that newer and/or premium level tires as opposed to inexpensive or worn tires will be in use on the car at a given time.

Figure 4 shows the percentage of tire defects according to age of the car, and the graph includes a trend line for each of four different driver age groups. In this graph, car age goes from new cars (0 years old) through four year old cars. Four driver age groups are defined as follows:

Drivers less than 23 years old;
Drivers 23-39 years old;
Drivers 40-59 years old
Drivers 60 years old or older

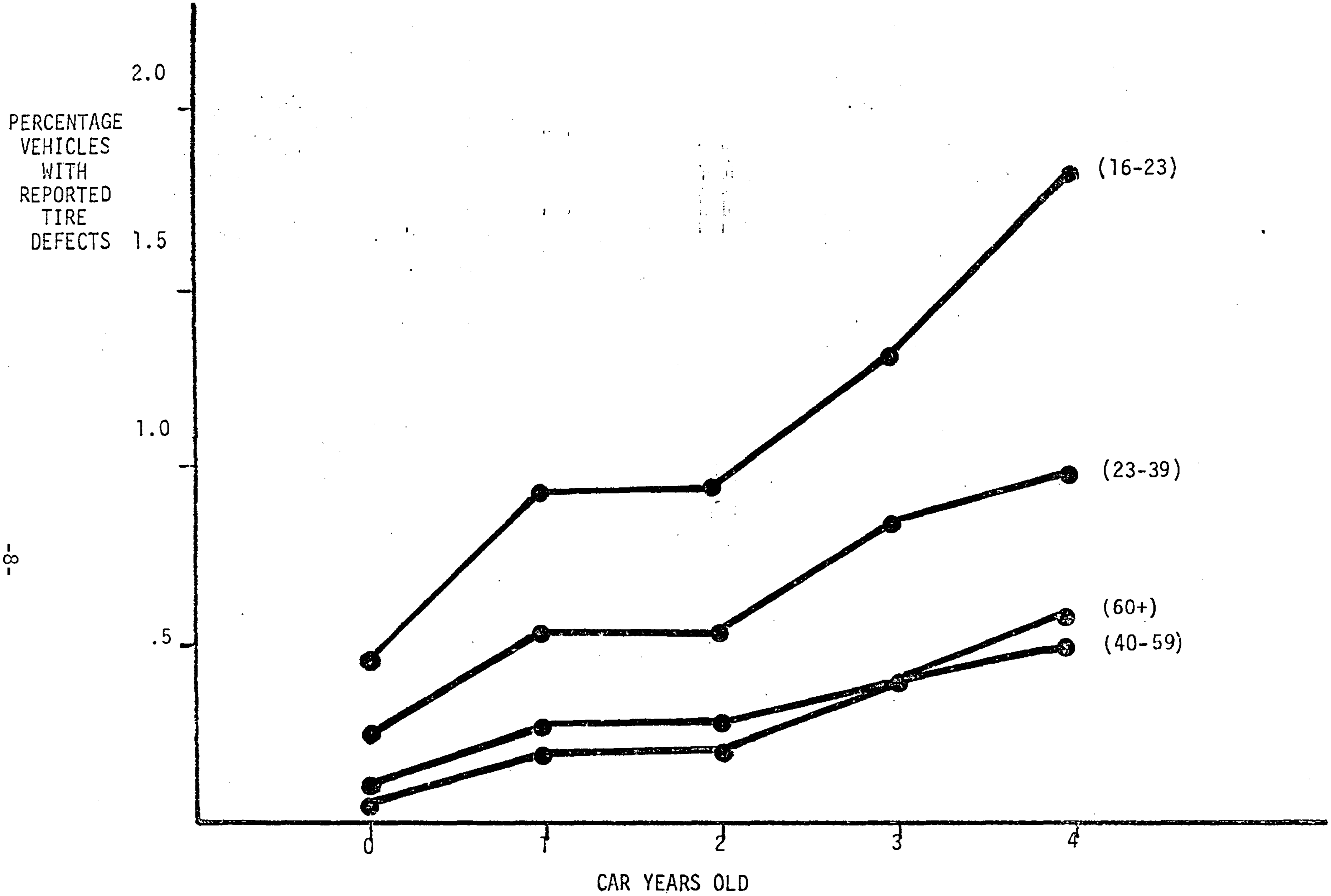

Figure 4. Percent tire defects by car age and driver age.

Figure 4 shows clearly both the pronounced driver age effect and the vehicle age effect. All data points for the <23 year old group show a higher percentage of tire defect accidents than all data points for the next older driver age group. In fact, except for one slight overlap the graphs show that each successively older driver age group is successively less often in an accident in which a tire defect is indicated.

Also, for each driver age group, the other expected relationship is confirmed in which the proportion of tire defects increases steadily with car age. In the older driver age group, the trend goes from scarcely any defects at all, up to about half of one percent. In contrast, for the youngest driver age group, the trend <u>starts</u> at about one half of one percent and goes up to more than triple that figure. It is obvious that any adequate description of tire defect behavior has to take into account both driver age and vehicle age. However, vehicle <u>size</u> is also a matter of importance.

Figure 5 has a similar format to the previous graphs in that car age is shown as a function of tire defect frequency. In this case however, the trend lines are shown for each of several different car <u>sizes</u> instead of driver age. The Subcompact is by far associated with the most tire defects. In a rather orderly way, tire defect frequency moves downward in relationship to successively larger car sizes. The Large car group has the least tire defects. Of course for each car size the frequency of tire defects also increases with vehicle age.

Thus, from most frequent tire defects to least, the Subcompact clearly has the highest proportion of tire defects. Next are the Compact and economy Import class (which behave essentially the same). Next is the intermediate size and finally the Large car.

There is therefore a suggestion in the two graphs (Figures 5 and Figure 4) that Subcompact cars and young drivers almost act as if they were following one trend level, in contrast to Large cars and older drivers.

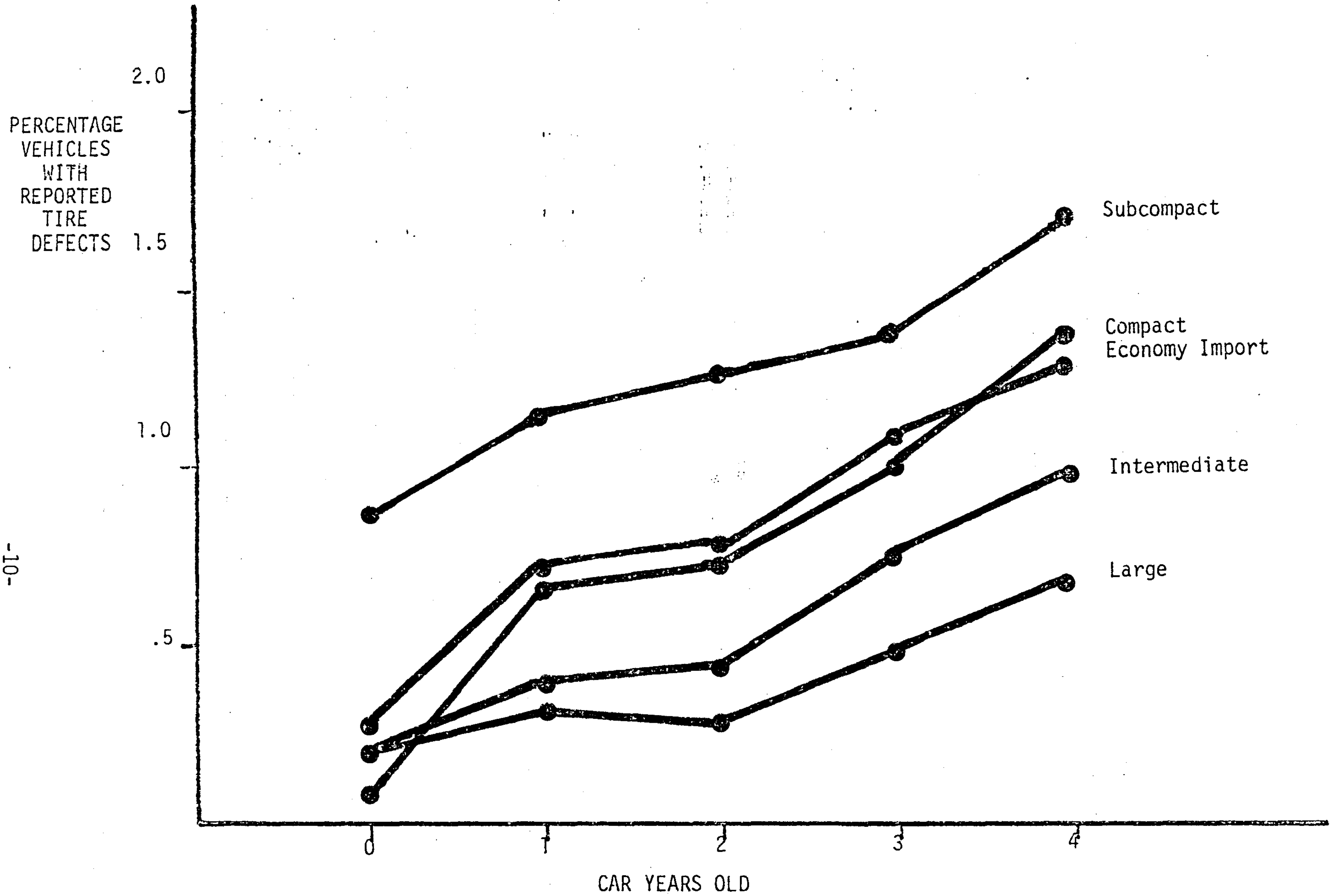

Figure 5. Percent tire defects by car age and car size.

The data thus suggest, as a working hypothesis, that there may be some kind of interaction in which the younger drivers more often drive small cars and older drivers drive the larger cars. To the extent that this is so, one is left to speculate whether the Subcompact's higher level of tire defect frequency is because young drivers more often are driving the Subcompacts, or whether the young drivers are associated with higher levels of reported tire defects because they are more often driving Subcompacts.

As a way of addressing this matter consider Figure 6. Figure 6 is a graph, as are the others, of tire defects vs age of car, but all data in Figure 6 are confined just to those drivers who are less than 23 years old. From among such drivers of rather similar age, data are shown with respect to car size. When this is done the patterns are somewhat more erratic because, of course, the sample size is smaller. Nevertheless for the <23 year old driver group the Subcompact is still generally the one with the highest percentage of reported tire defects, and the Large car, the one with the lowest. The Intermediate car size is next lowest. As before the Compacts and economy Imports are somewhat together on the chart, although there is a considerable amount of fluctuation because of the small sample. Thus, the car size "effect" still shows in this restricted driver age group.

Figure 7 has identical format except that the graph is confined to the next higher driver age group, drivers who are 23-39 years old. Once again, the same general relationships are seen, except that one can see that the entire graph is moved somewhat downward. That is, in Figure 7, a relatively small amount of the data fell above the one percent tire defect level, whereas in Graph 6, quite a few of the data points fell above 1 percent.

Figure 8 is the same format again, this time for the 40-59 year old driver group, and the immediate point is that for all car sizes, the overall level of

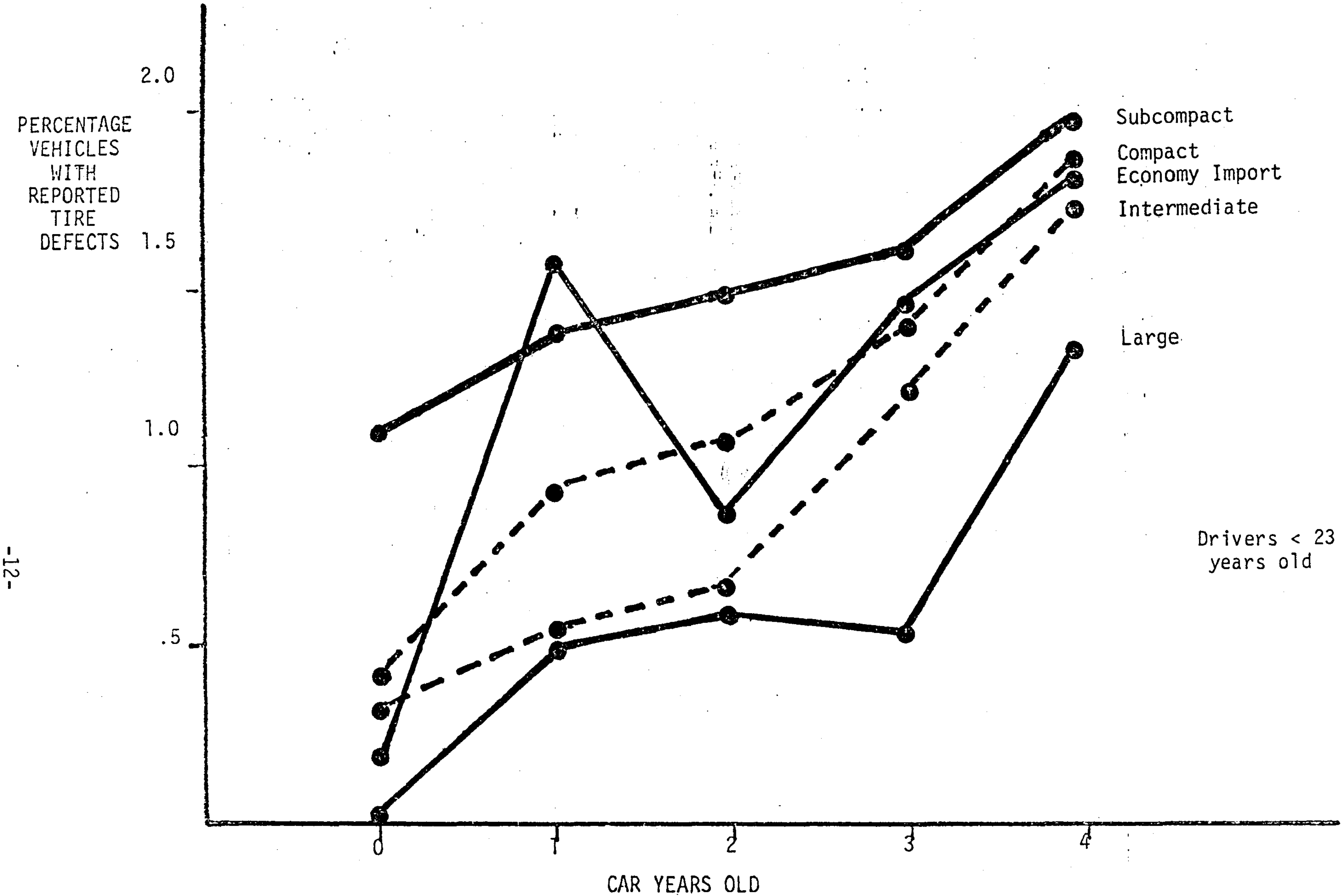

Figure 6. Tire defects related to car age and car size for drivers less than 23 years old.

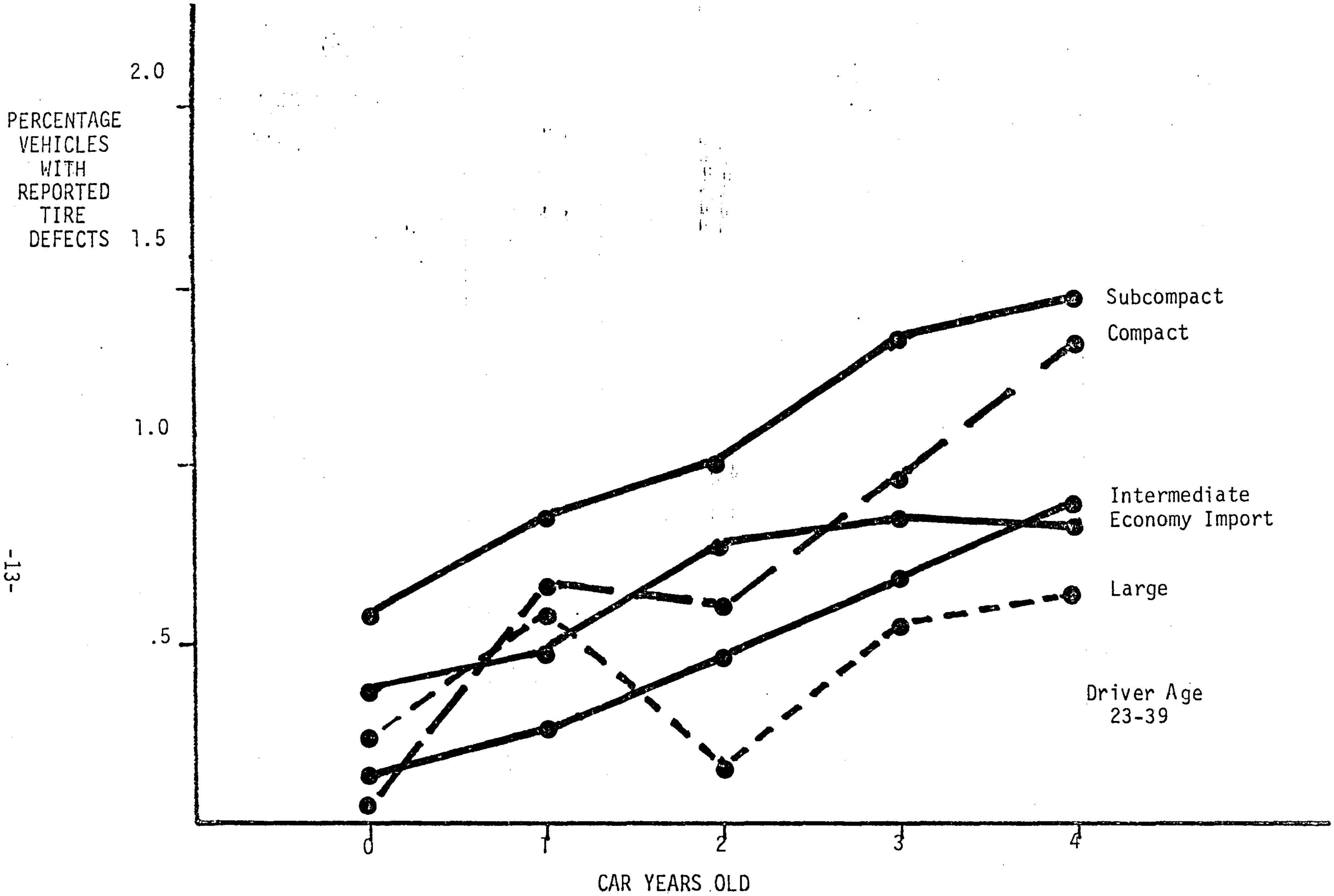

Figure 7. Tire defects related to car age and car size for drivers 23-39 years old.

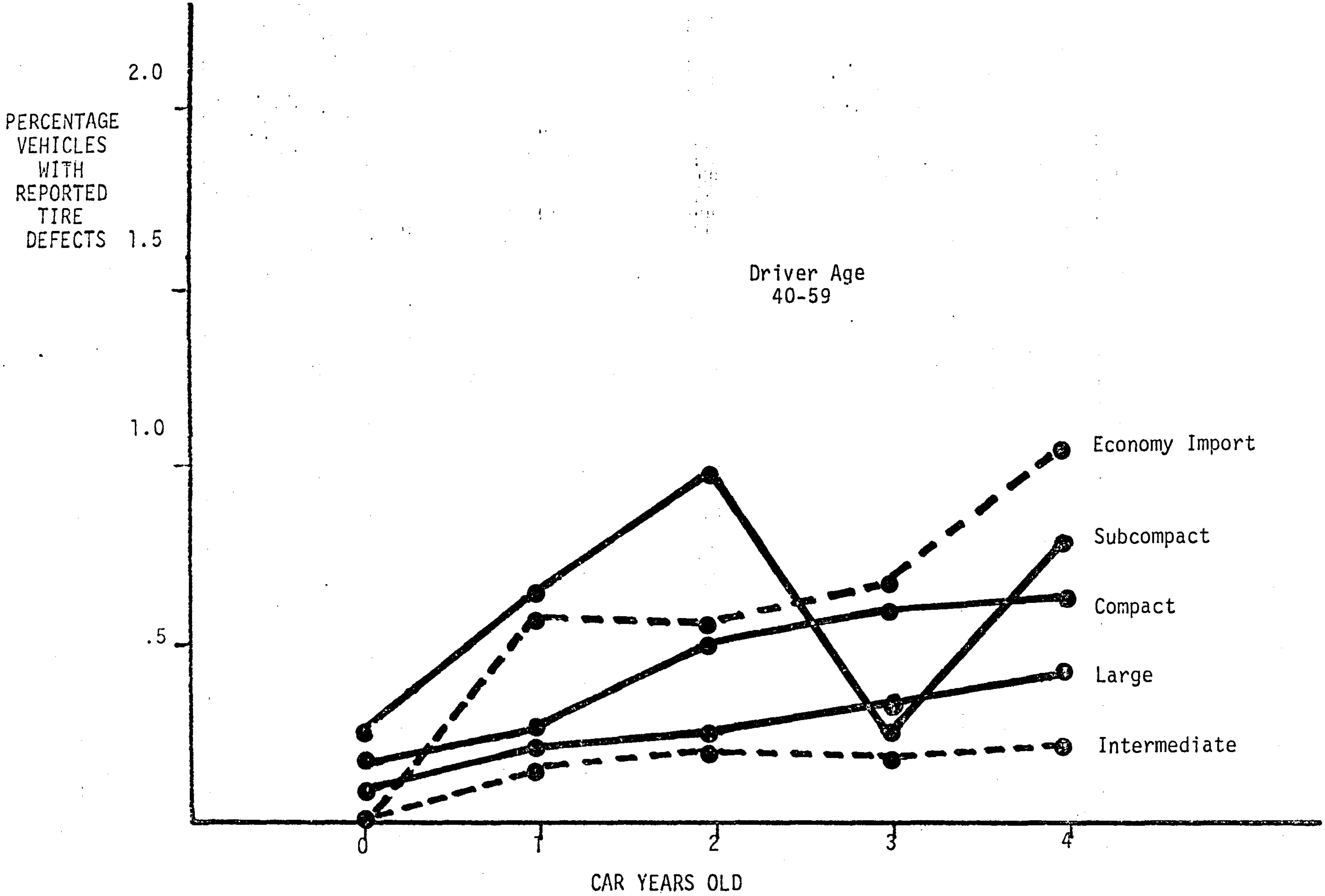

Figure 8. Tire defects related to car age and car size for drivers 40-59 years old.

tire defects is lower than in Figures 7 or 6. There is still the general relationship (although not entirely clear-cut) that the smaller the car, the higher the level of tire deficiencies within that category. Also, of course throughout all these graphs, the older the car the more frequent the tire defects.

Figure 9 shows the same kind of graph with respect to drivers who are 60 years old or older. Again, the Subcompact is higher than the other groups. Because of small numbers, there is not the same kind of clear-cut size difference seen in preceding graphs. Notice that the overall graph is quite low in terms of percent tire defects. The general level of tire defects is down at half of one percent or lower.

To summarize Figures 6-9 one sees that, first of all, regardless of the car size, tire defects are successively lower the older the driver age group. Within driver age groups there is still a discernable relationship in which the smaller the car, the higher the percentage of the tire defects, within a given driver age group. Also in all the graphs, tire defect percentage increases as the age of the car increases. Thus, tire deficiencies seem related to car size even when taking driver age into account.

The next five tables reverse the previous format, in a sense, in order to show the behavior of different size cars, and to show this behavior for the driver age groups within the several car sizes. Figure 10 is a graph in the same format used before showing car age as a function of tire defects. However, this graph is confined just to the experience of Large cars, and within that graph trend lines are shown for each of the four different driver age groups. The younger driver age group showed the higher level of tire defect. However, the overall tire defect level for the Large cars are fairly low with most of the data points for the various age groups being at half of one percent or lower.

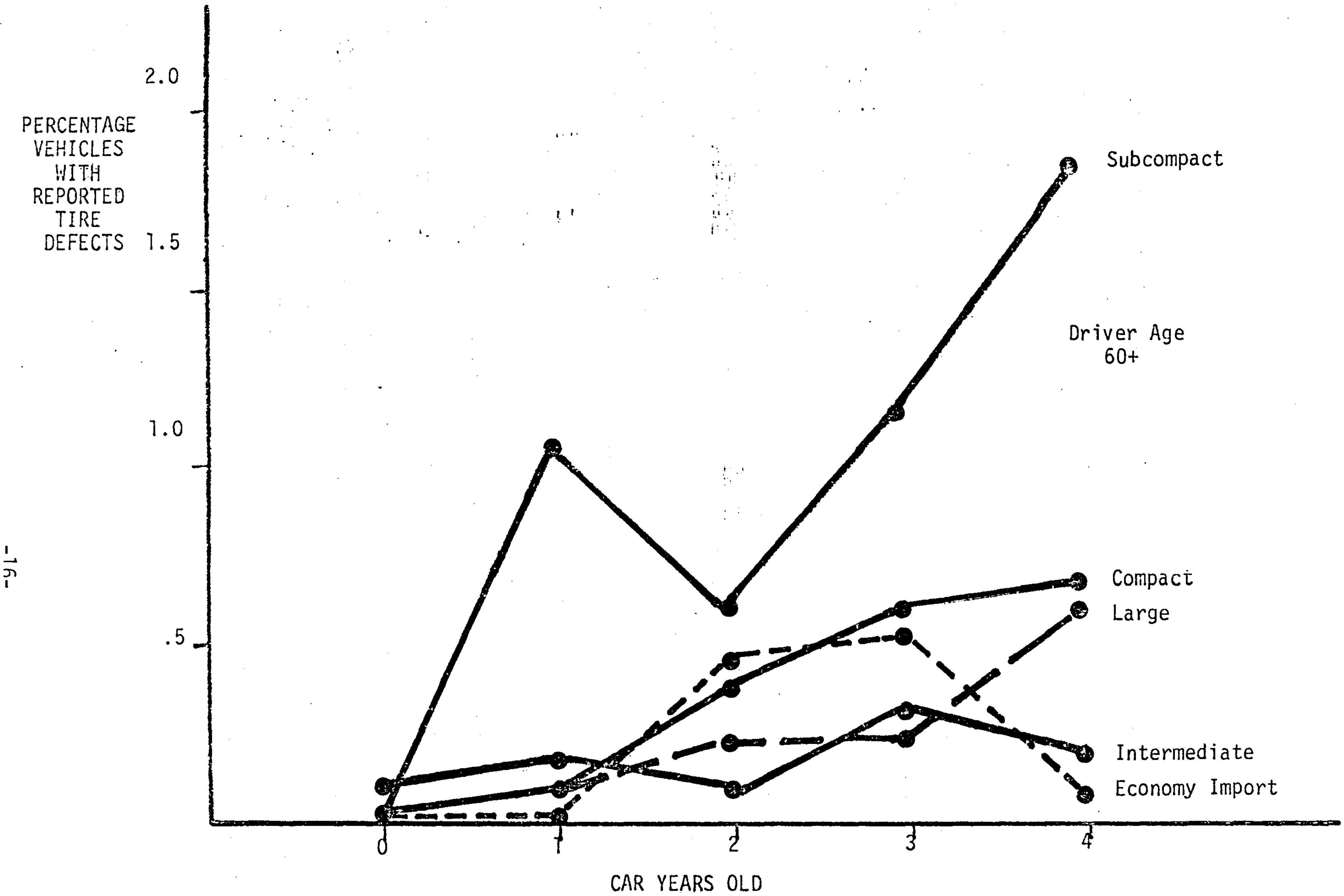

Figure 9. Tire defects related to car age and car size for drivers 60+ years old.

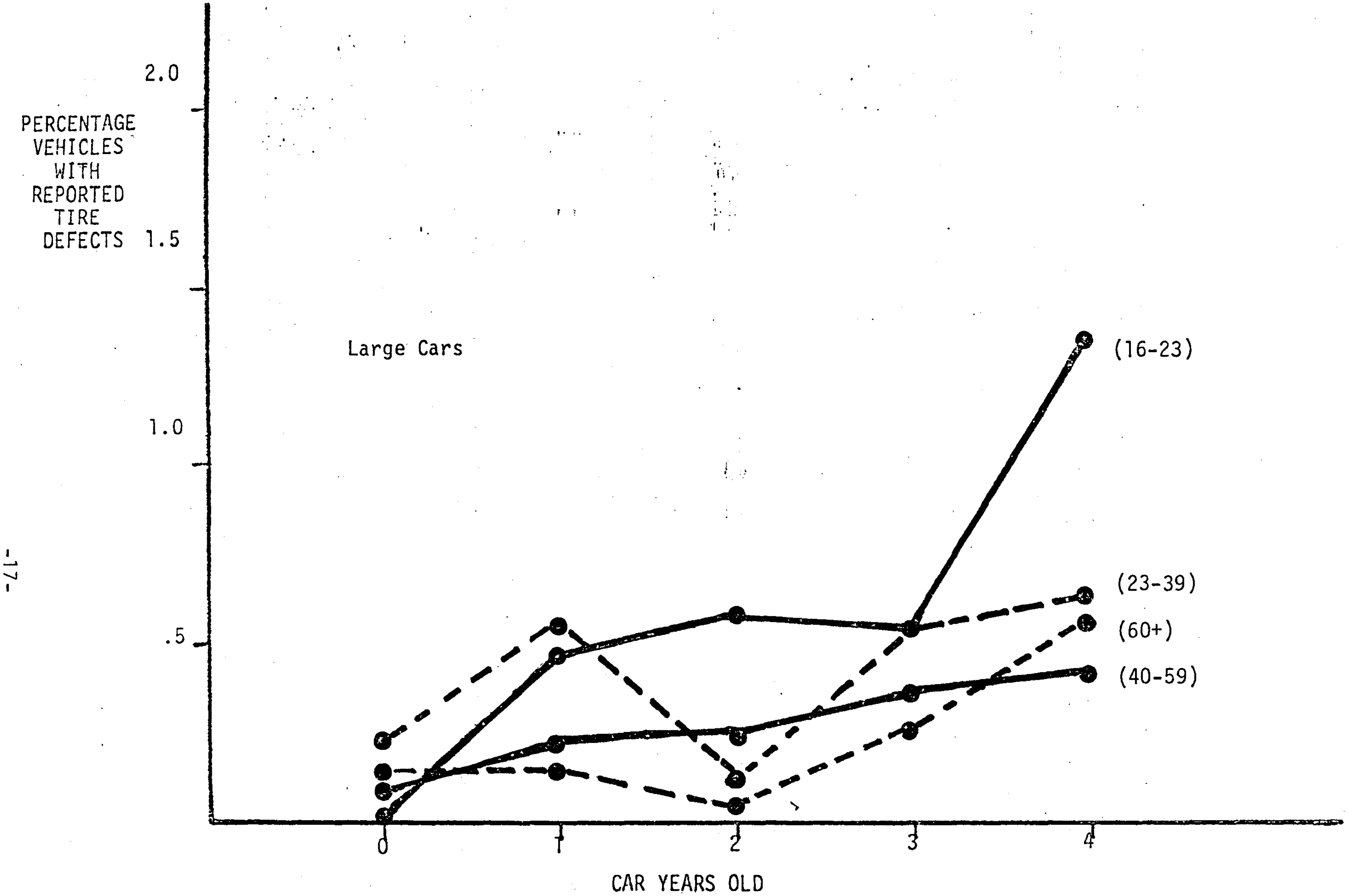

Figure 10. Tire defects related to vehicle age and driver age for large cars.

Figure 11 shows the same format for Intermediate cars. Here there is a rather clear-cut driver age effect with the young drivers having the highest tire defect percentage within the Intermediate car group. The next driver age group is next highest, and then the two older driver age groups are quite low and rather indistinct from one another. The Intermediate car certainly gives the impression that, within that car size, tire defects are much more likely to be associated with younger drivers.

Figure 12 shows the same format for Compact cars and again the ranking of the different age groups is quite similar to what has been seen before. Also, the overall elevation of all the data points is higher with a good many of the points falling above the one percent failure level.

Figure 13 is the same information for Subcompact cars and one sees that the general level of tire defects is much higher, with some data points at 1 and 2 percent. In general, there is a relationship in which the young drivers are highest and the older drivers are lowest except, however, that the oldest age group fluctuates presumably due to small sample size.

Figure 14 is the final car group size and it shows the Economy Imports. Trends on this graph behave somewhat like the Compacts or Subcompacts, having a somewhat higher proportion of tire failure and somewhat related to driver age seen before.

In reviewing these five graphs, Figures 10-14, the impression is certainly consistent with what was seen earlier and that is, that a triple effect is evident. First, tire defects show up more frequently the smaller the car, second, the younger the driver the more the tire defects, and third, the older the car, the more the tire defects.

Figure 15 has four trend lines which compare the Large and the Subcompact car. The two lines depicting the Large car unadjusted data and Subcompact

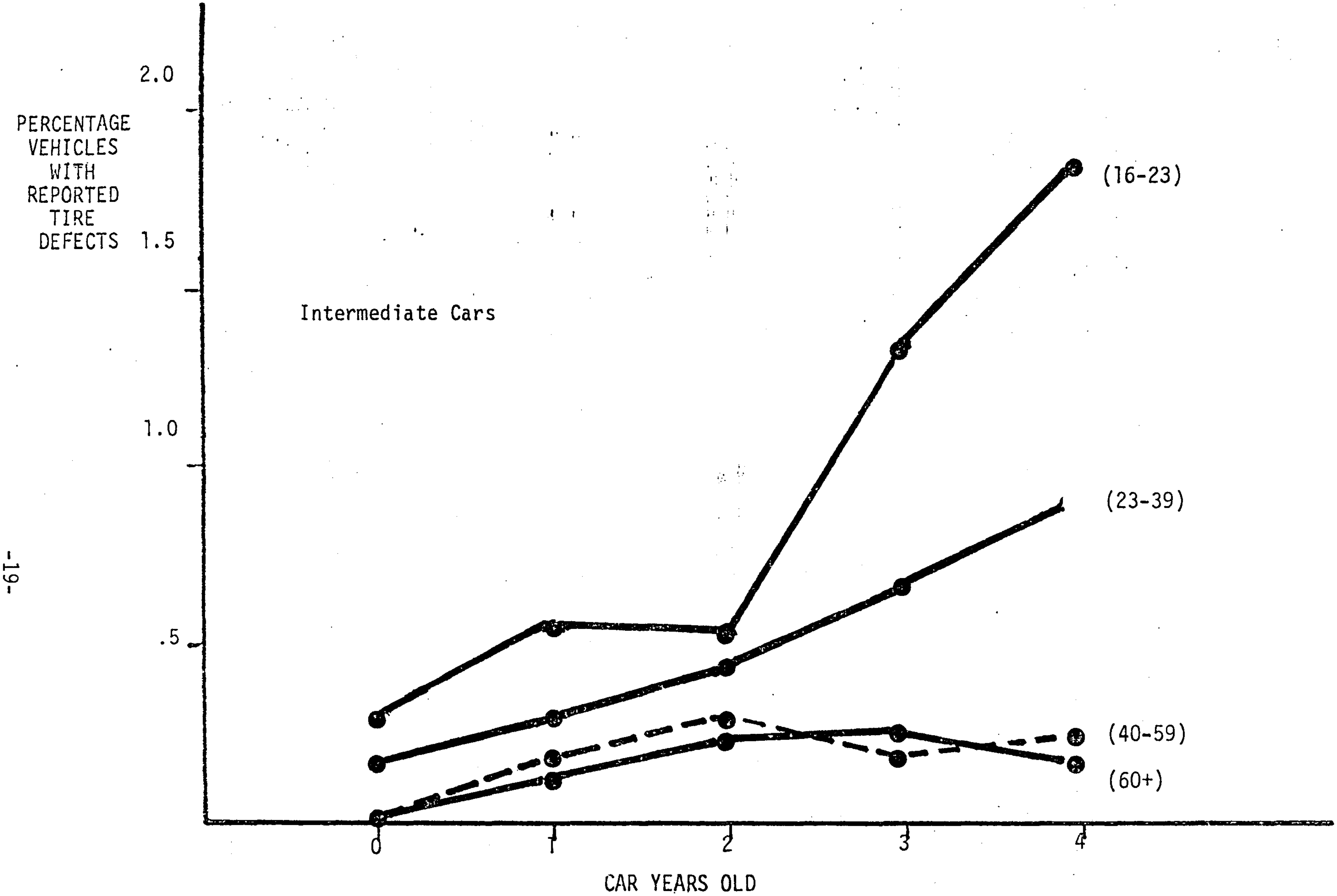

Figure 11. Tire defects related to vehicle age and driver age for intermediate cars.

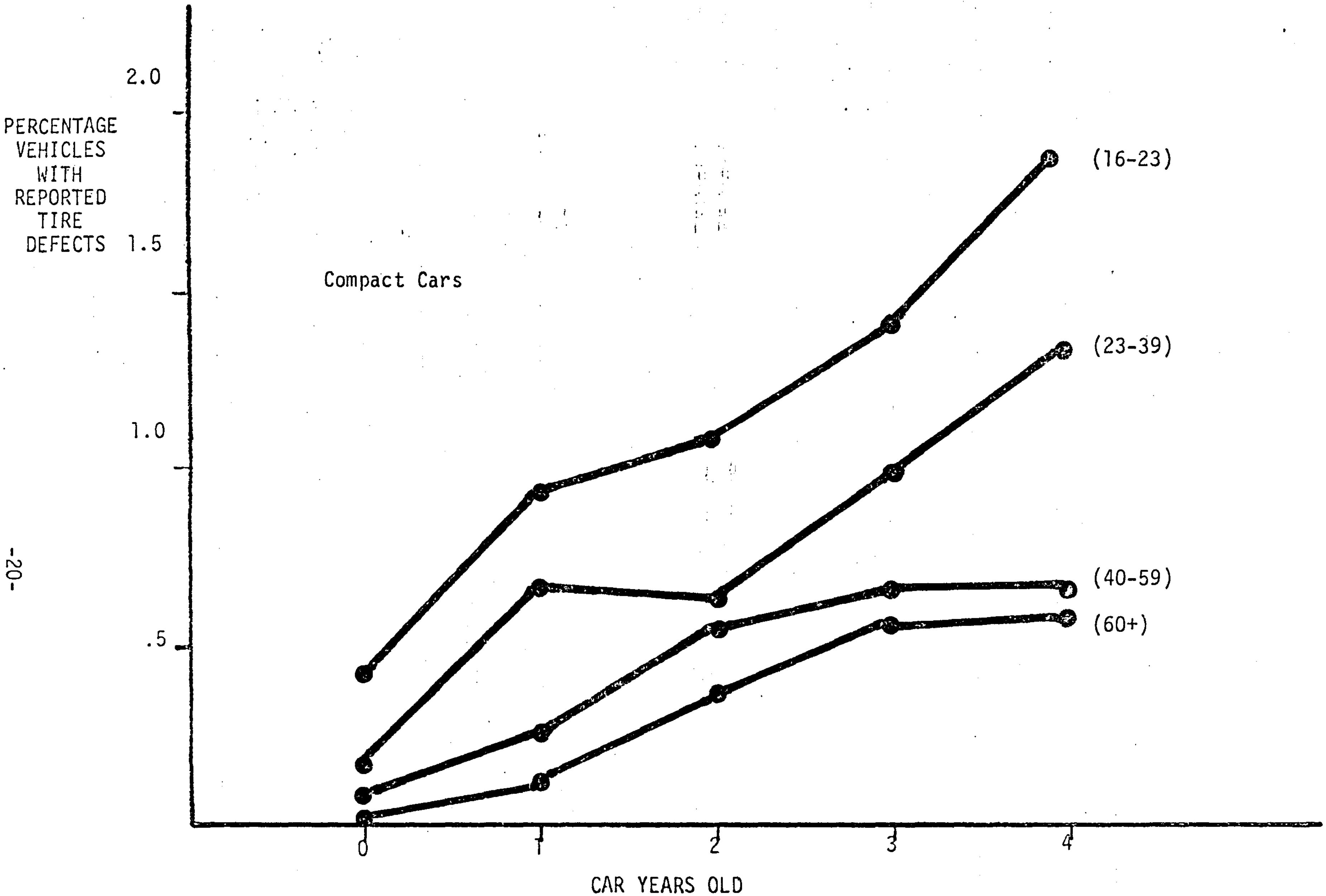

Figure 12. Tire defects related to vehicle age and driver age for compact cars.

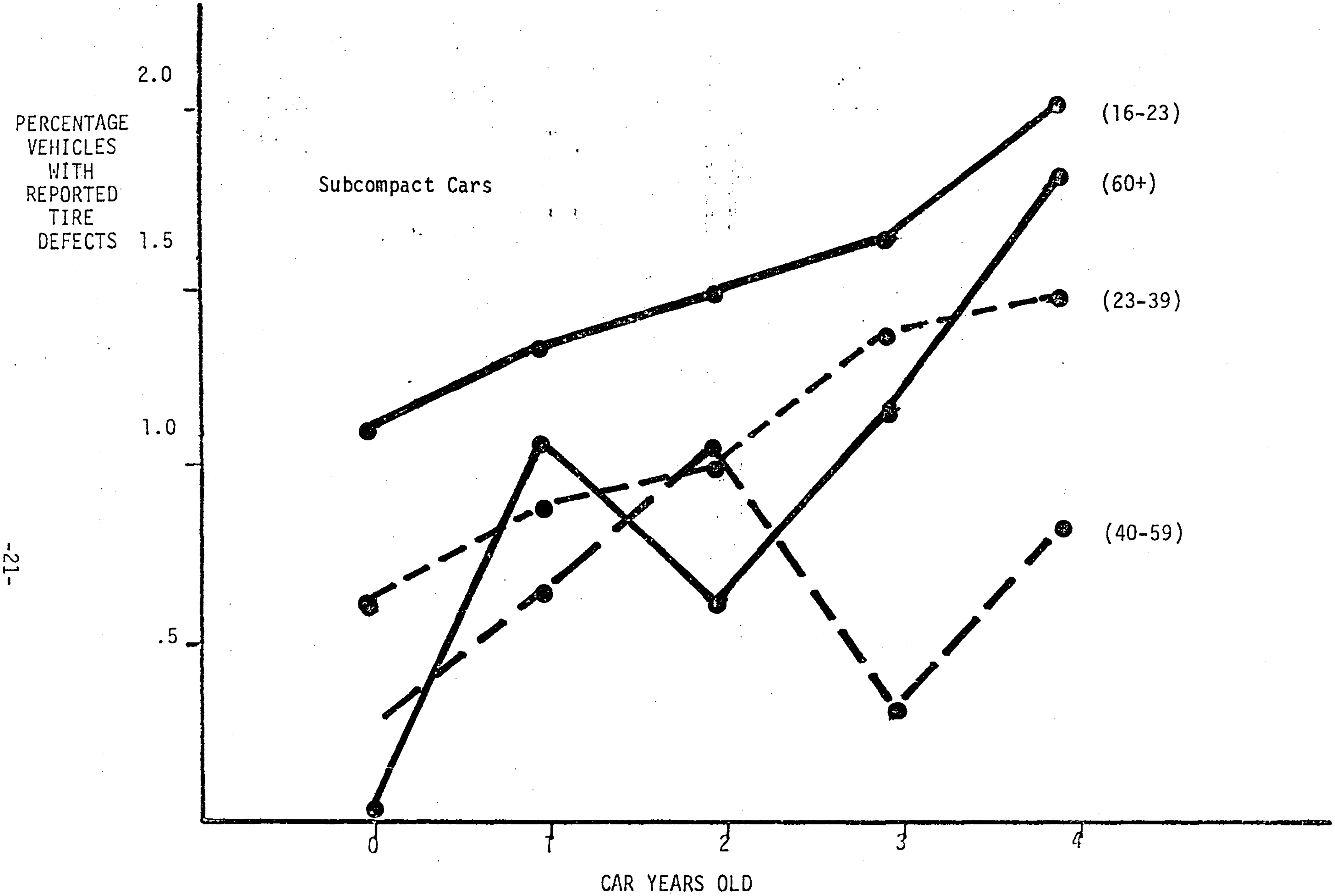

Figure 13. Tire defects related to vehicle age and driver age for subcompact cars.

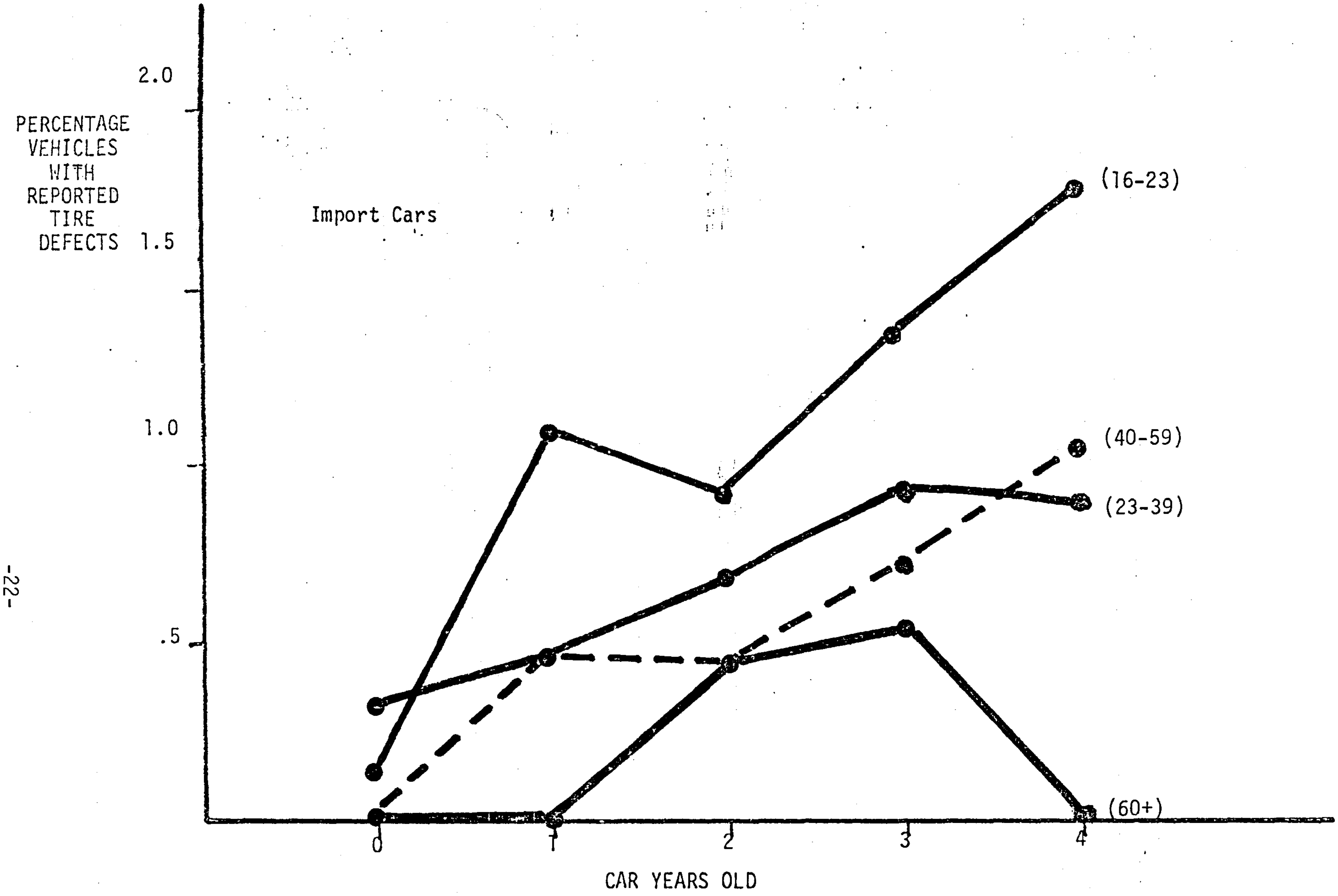

Figure 14. Tire defects related to vehicle age and driver age for import cars.

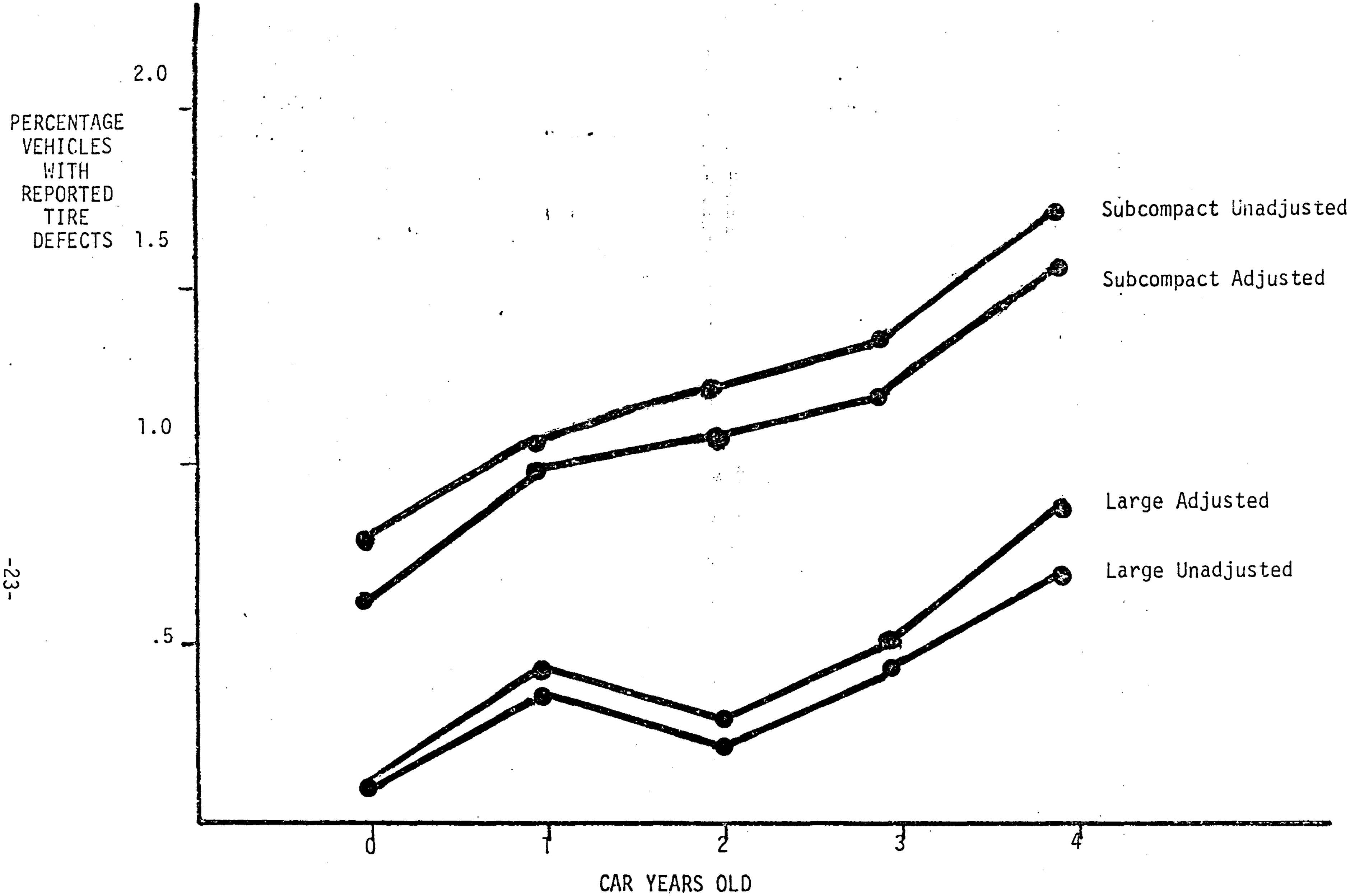

Figure 15. Tire defects related to car age for large cars vs. subcompact cars unadjusted and age adjusted data.

unadjusted data show that the Subcompact is very much higher than the Large car in tire defect percent. However, those two lines do not take into account the age differences of the drivers. Table 1 shows this difference. In Table 1, fully 51 percent of the subcompact cars in this accident sample were driven by persons less than 23 years old. Only three percent of Subcompact cars were driven by persons 60 years old and older.

On the other hand, with respect to Large cars, only 14 percent were driven by persons in the youngest age group. Thus, one can see the necessity of taking driver age into account. Therefore, the other two lines in Figure 15 are adjusted figures. These adjusted figures are plotted as if both car groups had drivers with identical age distributions -- that distribution being the overall driver age distribution of all drivers in the sample.

When the Large car figures are adjusted to take driver age into account, the tire defect rates move up higher. That indicates that part of the "good" performance of the large car was because it was aided by the presence of older drivers. Likewise, when the Subcompact figures are adjusted, they become better showing that some of the relatively poor tire defect performance of the subcompact cars is associated with the young drivers. Therefore, the difference between the adjusted figures for the Large and Subcompact car is less than the difference between the unadjusted figures. However, the car size difference is still quite clear-cut with the Subcompact tire deficiency rates being twice as high as that for the Large cars.

All of this, of course, has implications for highway safety. On the vehicle side, one can speculate what might be the source of the higher frequency of tire problems with smaller cars. Is it because the tire reserve is less for small cars and therefore, given the average conditions of small car load and use, that these cars are being operated closer to the limits of the tires? Is it because

		CAR SIZE				
		Large	Intermediate	Compact	Subcompact	Import
	< 23	7656 13.69%	20556 27.51%	18314 34.88%	19175 5.14%	
Driver Age	23-39	18950 33.88%	34797 46.56%	19500 37.14%	13660 36.61%	
	40-59	20190 36.07%	14636 19.58%	9553 18.15%	3521 9.44%	
	60+	9142 16.34%	4746 6.35%	5135 9.78%	952 2.55%	
		55938 100%	74735 100%	52502 100%	37308 100%	

Table 1. CAR SIZE BY DRIVER AGE

the smaller tires must make more rotations per mile travel, and therefore are exposed to more flexing? Is it because the relative level of tire durability of tires on Subcompact cars is less than that on Large cars? These are all questions worthy of attention by state and national safety officials, manufacturers and consumers.

On the other hand, the data are also important in terms of the role of the driver. Presumably, a considerable portion of the problems with tires comes from situations in which tires are worn. The driver age factors needs to be taken into account because it may be an economic reality that younger people cannot by virtue of their economic position, are in less good position to avoid poorer on their cars. Older and more affluent drivers may be more able to obtain and maintain better tires. It also may be that, likewise because of cost considerations, young people more often drive the small cars.

This is information that should be given to the public:

1. Tire deficiencies should be a matter of concern, to you the driver.
2. Having adequate tires and properly maintaining and caring for them is important.
3. That the risk level is related to car age, car size, and driver age.

Also the state motor vehicle inspection program needs to take these findings into account. Since tires are an inspection item, perhaps there is an implication that tire inspection should be more thorough for small cars. Of course, that would require a change in the statute. Failing that, however, inspectors could be alerted to the greater problem that exists with the smaller cars and older cars.

Tragically, as in other ways, young people seem to be at the greatest risk. Young people more often ride in smaller cars, older cars, and cars with less new equipment. This is coupled with the fact that young people are at a much higher risk of an accident in the first place. This means that economics and family practices of our society are too often such that we <u>see to it</u> that the most vulnerable drivers of our society are driving the most risky vehicles.

In summary this study has shown significant differences in the relative frequency of reported tire defects based on (1) age of car, (2) size of car, and (3) age of driver. The range of difference is one word, and is worthy of attention and consideration with respect to vehicle factors as well as driver factors.

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

OVERALL

MODEL YEAR	1977 TIRE DEFECT	1977 TOTAL	1977 %	1978 TIRE DEFECT	1978 TOTAL	1978 %	1979 TIRE DEFECT	1979 TOTAL	1979 %	1980 TIRE DEFECT	1980 TOTAL	1980 %	ALL YEARS TIRE DEFECT	ALL YEARS TOTAL	ALL YEARS %
74	144	13781	1.04	209	15867	1.32	193	14769	1.31	165	13008	1.27	711	57425	1.24
75	59	9390	0.63	85	10543	0.81	120	10242	1.17	82	8785	0.93	346	38961	0.89
76	89	14024	0.63	99	15359	0.64	104	14690	0.71	118	13472	0.88	410	57545	0.71
77	28	10142	0.28	85	16090	0.53	75	15138	0.50	116	14088	0.82	304	55458	0.55
78	0	431	0.00	27	11248	0.24	89	15952	0.56	89	14577	0.61	205	42208	0.49
79				2	527	0.38	28	10700	0.26	78	15243	0.51	108	26470	0.41
TOTAL													2084	278067	0.75

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=LARGE

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	15	3262	0.46	29	3631	0.80	26	3284	0.79	33	3065	1.08	103	13242	0.78
75	4	2166	0.18	8	2536	0.32	16	2365	0.68	11	2076	0.53	39	9143	0.43
76	15	2818	0.53	6	2964	0.20	12	2835	0.42	12	2607	0.46	45	11224	0.40
77	1	2102	0.05	10	3550	0.30	9	3266	0.28	14	2975	0.47	34	11693	0.29
78	0	101	0.00	3	2015	0.15	8	2769	0.29	4	2674	0.15	15	7559	0.20
79				0	122	0.00	4	1908	0.21	9	2757	0.33	13	4787	0.27
TOTAL													249	57648	0.43

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=INTERMEDIATE

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	35	3550	0.99	44	4069	1.08	40	3748	1.07	37	3238	1.14	156	14605	1.07
75	10	2631	0.38	25	2986	0.84	32	2891	1.11	23	2477	0.93	90	10985	0.82
76	13	3924	0.33	18	4225	0.43	20	4026	0.50	29	3847	0.75	80	16022	0.50
77	6	3416	0.18	16	5032	0.32	17	4765	0.36	28	4617	0.61	67	17830	0.38
78	0	126	0.00	4	3102	0.13	14	4448	0.31	21	4055	0.52	39	11731	0.33
79				0	150	0.00	3	2403	0.12	5	3262	0.15	8	5815	0.14
TOTAL													440	76988	0.57

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=COMPACT

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	35	2380	1.47	42	2643	1.59	39	2575	1.51	44	2188	2.01	160	9786	1.63
75	20	1734	1.15	15	1944	0.77	26	1907	1.36	21	1639	1.28	82	7224	1.14
76	16	2738	0.58	24	3129	0.77	27	3004	0.90	31	2814	1.10	98	11685	0.84
77	3	1840	0.16	14	3094	0.45	14	2923	0.48	22	2663	0.83	53	10520	0.50
78	0	72	0.00	5	2399	0.21	24	3275	0.73	19	3047	0.62	48	8793	0.55
79				1	131	0.76	5	2382	0.21	23	3405	0.68	29	5918	0.49
TOTAL													470	53926	0.87

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=SUBCOMPACT

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	33	2306	1.43	48	2584	1.86	48	2380	2.02	31	2097	1.48	160	9367	1.71
75	13	1448	0.90	20	1453	1.38	28	1450	1.93	16	1167	1.37	77	5518	1.40
76	24	2191	1.10	28	2250	1.24	21	2110	1.00	22	1863	1.18	95	8414	1.13
77	13	1111	1.17	26	1798	1.45	22	1624	1.35	26	1422	1.83	87	5955	1.46
78	0	68	0.00	10	1626	0.62	22	2118	1.04	25	1796	1.39	57	5608	1.02
79				1	59	1.69	11	1459	0.75	17	1919	0.89	29	3437	0.84
TOTAL													505	38299	1.32

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=ECONOMY IMPORT

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	24	2058	1.17	41	2544	1.61	38	2422	1.57	17	2099	0.81	120	9123	1.32
75	11	1252	0.88	16	1315	1.22	13	1334	0.97	9	1167	0.77	49	5068	0.97
76	20	2097	0.95	19	2371	0.80	21	2332	0.90	17	1965	0.87	77	8765	0.88
77	5	1531	0.33	16	2417	0.66	12	2241	0.54	23	2121	1.08	56	8310	0.67
78	0	58	0.00	5	1890	0.26	19	2933	0.65	18	2692	0.67	42	7573	0.55
79				0	46	0.00	5	2228	0.22	22	3423	0.64	27	5697	0.47
TOTAL													371	44536	0.83

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

ZE=LARGE DR_AGE=<23

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	2	499	0.40	10	637	1.57	10	588	1.70	12	568	2.11	34	2292	1.48
75	1	319	0.31	2	403	0.50	5	397	1.26	3	370	0.81	11	1489	0.74
76	3	278	1.08	2	348	0.57	2	375	0.53	4	365	1.10	11	1366	0.81
77	0	197	0.00	0	350	0.00	5	351	1.42	3	340	0.88	8	1238	0.65
78	0	7	0.00	0	181	0.00	2	304	0.66	0	313	0.00	2	805	0.25
79				0	7	0.00	0	190	0.00	1	269	0.37	1	466	0.21
TOTAL													67	7656	0.88

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=LARGE DR_AGE=23-39

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	5	1145	0.44	9	1209	0.74	11	1026	1.07	9	904	1.00	34	4284	0.79
75	2	708	0.28	4	823	0.49	5	734	0.68	6	645	0.93	17	2910	0.58
76	9	990	0.91	2	1010	0.20	4	888	0.45	3	759	0.40	18	3647	0.49
77	0	782	0.00	5	1125	0.44	0	1036	0.00	7	875	0.80	12	3818	0.31
78	0	35	0.00	1	721	0.14	3	934	0.32	0	833	0.00	4	2523	0.16
79				0	44	0.00	4	689	0.58	6	1035	0.58	10	1768	0.57
TOTAL													95	18950	0.50

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=LARGE DR_AGE=40-59

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	6	1151	0.52	5	1167	0.43	3	979	0.31	9	907	0.99	23	4204	0.55
75	1	813	0.12	0	893	0.00	5	775	0.65	0	655	0.00	6	3136	0.19
76	2	1096	0.18	2	1137	0.18	5	1406	0.50	2	852	0.23	11	4091	0.27
77	1	811	0.12	4	1284	0.31	3	1207	0.25	4	1067	0.37	12	4369	0.27
78	0	49	0.00	1	766	0.13	2	1012	0.20	4	932	0.43	7	2759	0.25
79				0	54	0.00	0	677	0.00	1	900	0.11	1	1631	0.06
TOTAL													60	20190	0.30

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=LARGE DR_AGE=60+

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	2	452	0.44	4	550	0.73	2	511	0.39	2	517	0.39	10	2030	0.49
75	0	317	0.00	2	373	0.54	1	357	0.28	0	311	0.00	3	1358	0.22
76	1	445	0.22	0	432	0.00	1	452	0.22	3	499	0.60	5	1828	0.27
77	0	303	0.00	0	545	0.00	1	521	0.19	0	566	0.00	1	1935	0.05
78	0	10	0.00	1	328	0.30	1	424	0.24	0	487	0.00	2	1249	0.16
79				0	16	0.00	0	275	0.00	1	451	0.22	1	742	0.13
TOTAL													22	9142	0.24

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=INTERMEDIATE DR_AGE=<23

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	22	1149	1.91	23	1268	1.81	19	1213	1.57	15	1053	1.42	79	4683	1.69
75	4	710	0.56	10	899	1.11	19	832	2.28	7	731	0.96	40	3172	1.26
76	5	1039	0.48	7	1147	0.61	9	1121	0.80	14	1086	1.29	35	4393	0.80
77	2	871	0.23	7	1181	0.59	7	1208	0.58	12	1171	1.02	28	4431	0.63
78	0	28	0.00	2	664	0.30	5	963	0.52	4	907	0.44	11	2562	0.43
79				0	25	0.00	2	556	0.36	3	734	0.41	5	1315	0.38
TOTAL													198	20556	0.96

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=INTERMEDIATE DR_AGE=23-39

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	11	1585	0.69	18	1799	1.00	11	1541	0.71	16	1328	1.20	56	6253	0.90
75	5	1299	0.38	11	1322	0.83	10	1247	0.80	11	1036	1.06	37	4904	0.75
76	6	1837	0.33	9	1929	0.47	10	1724	0.58	13	1608	0.81	38	7098	0.54
77	3	1642	0.18	8	2392	0.33	7	2100	0.33	13	1963	0.66	31	8097	0.38
78	0	58	0.00	2	1578	0.13	7	2215	0.32	11	1874	0.59	20	5725	0.35
79				0	84	0.00	1	1147	0.09	0	1489	0.00	1	2720	0.04
TOTAL													183	34797	0.53

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=INTERMEDIATE DR_AGE=40-59

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	2	624	0.32	2	684	0.29	8	573	1.40	5	490	1.02	17	2371	0.72
75	1	462	0.22	3	538	0.56	1	470	0.21	3	419	0.72	8	1889	0.42
76	2	808	0.25	1	826	0.12	0	747	0.00	1	687	0.15	4	3068	0.13
77	1	731	0.14	1	1098	0.09	2	969	0.21	0	944	0.00	4	3742	0.11
78	0	30	0.00	0	630	0.00	1	856	0.12	3	831	0.36	4	2347	0.17
79				0	34	0.00	0	489	0.00	1	696	0.14	1	1219	0.08
TOTAL													38	14636	0.26

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=INTERMEDIATE DR_AGE=60+

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	0	179	0.00	0	230	0.00	0	239	0.00	0	197	0.00	0	845	0.00
75	0	152	0.00	1	177	0.56	1	193	0.52	0	169	0.00	2	691	0.29
76	0	223	0.00	1	264	0.38	0	266	0.00	0	281	0.00	1	1034	0.10
77	0	153	0.00	0	300	0.00	0	313	0.00	1	324	0.31	1	1090	0.09
78	0	10	0.00	0	183	0.00	0	252	0.00	1	293	0.34	1	738	0.14
79				0	4	0.00	0	131	0.00	1	213	0.47	1	348	0.29
TOTAL													6	4746	0.13

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=COMPACT DR_AGE=<23

MODEL YEAR	1977 TIRE DEFECT	1977 TOTAL	1977 %	1978 TIRE DEFECT	1978 TOTAL	1978 %	1979 TIRE DEFECT	1979 TOTAL	1979 %	1980 TIRE DEFECT	1980 TOTAL	1980 %	ALL YEARS TIRE DEFECT	ALL YEARS TOTAL	ALL YEARS %
74	18	954	1.89	23	1063	2.16	21	986	2.13	24	834	2.88	86	3837	2.24
75	11	577	1.91	6	689	0.87	13	696	1.87	7	537	1.30	37	2499	1.48
76	7	898	0.78	10	1040	0.96	12	955	1.26	13	842	1.54	42	3735	1.12
77	2	648	0.31	8	990	0.81	6	854	0.70	11	748	1.47	27	3230	0.84
78	0	35	0.00	4	779	0.51	10	991	1.01	9	891	1.01	23	2696	0.85
79				0	58	0.00	4	1022	0.39	13	1237	1.05	17	2317	0.73
TOTAL													232	18314	1.27

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=COMPACT DR_AGE=23-39

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	12	818	1.47	13	881	1.48	15	853	1.76	14	745	1.88	54	3297	1.64
75	4	636	0.63	5	681	0.73	10	642	1.56	13	625	2.08	32	2584	1.24
76	9	1016	0.89	11	1099	1.00	10	1082	0.92	10	973	1.03	40	4170	0.96
77	0	693	0.00	5	1146	0.44	5	1030	0.49	7	976	0.72	17	3845	0.44
78	0	23	0.00	0	946	0.00	11	1294	0.85	4	1124	0.36	15	3387	0.44
79				1	50	2.00	0	877	0.00	7	1290	0.54	8	2217	0.36
TOTAL													166	19500	0.85

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=COMPACT DR_AGE=40-59

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	3	398	0.75	2	386	0.52	2	380	0.53	2	295	0.68	9	1459	0.62
75	5	346	1.45	3	358	0.84	1	310	0.32	1	247	0.40	10	1261	0.79
76	0	555	0.00	1	627	0.16	1	535	0.19	5	563	0.89	7	2280	0.31
77	1	364	0.27	1	632	0.16	2	582	0.34	4	515	0.78	8	2093	0.38
78	0	12	0.00	0	433	0.00	2	577	0.35	3	597	0.50	5	1619	0.31
79				0	15	0.00	1	293	0.34	2	533	0.38	3	841	0.36
TOTAL													42	9553	0.44

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=COMPACT DR_AGE=60+

MODEL YEAR	1977 TIRE DEFECT	1977 TOTAL	1977 %	1978 TIRE DEFECT	1978 TOTAL	1978 %	1979 TIRE DEFECT	1979 TOTAL	1979 %	1980 TIRE DEFECT	1980 TOTAL	1980 %	ALL YEARS TIRE DEFECT	ALL YEARS TOTAL	ALL YEARS %
74	2	200	1.00	2	275	0.73	0	272	0.00	1	223	0.45	5	970	0.52
75	0	167	0.00	1	196	0.51	1	197	0.51	0	166	0.00	2	726	0.28
76	0	259	0.00	1	321	0.31	3	330	0.91	2	319	0.63	6	1229	0.49
77	0	138	0.00	0	277	0.00	1	342	0.29	0	330	0.00	1	1087	0.09
78	0	2	0.00	0	194	0.00	0	301	0.00	2	307	0.65	2	804	0.25
79				0	7	0.00	0	111	0.00	1	201	0.50	1	319	0.31
TOTAL													17	5135	0.33

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=SUBCOMPACT DR_AGE=<23

MODEL YEAR	1977 TIRE DEFECT	1977 TOTAL	1977 %	1978 TIRE DEFECT	1978 TOTAL	1978 %	1979 TIRE DEFECT	1979 TOTAL	1979 %	1980 TIRE DEFECT	1980 TOTAL	1980 %	ALL YEARS TIRE DEFECT	ALL YEARS TOTAL	ALL YEARS %
74	20	1137	1.76	27	1383	1.95	32	1239	2.58	25	1034	2.42	104	4793	2.17
75	8	739	1.08	13	763	1.70	20	758	2.64	6	578	1.04	47	2838	1.66
76	16	1145	1.40	16	1141	1.40	12	1022	1.17	14	903	1.55	58	4211	1.38
77	9	600	1.50	14	947	1.48	13	745	1.74	13	658	1.98	49	2950	1.66
78	0	37	0.00	8	890	0.90	11	1044	1.05	14	787	1.78	33	2758	1.20
79				1	28	3.57	7	710	0.99	14	887	1.58	22	1625	1.35
TOTAL													313	19175	1.63

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=SUBCOMPACT DR_AGE=23-39

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	11	893	1.23	18	877	2.05	13	768	1.69	5	740	0.68	47	3278	1.43
75	4	547	0.73	7	503	1.39	5	467	1.07	7	410	1.71	23	1927	1.19
76	6	776	0.77	9	826	1.09	7	735	0.95	6	673	0.89	28	3010	0.93
77	3	384	0.78	8	619	1.29	6	615	0.98	11	540	2.04	28	2158	1.30
78	0	23	0.00	2	547	0.37	9	759	1.19	8	702	1.14	19	2031	0.94
79				0	24	0.00	4	530	0.75	2	702	0.28	6	1256	0.48
TOTAL													151	13660	1.11

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=SUBCOMPACT DR_AGE=40-59

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	1	214	0.47	1	213	0.47	2	203	0.99	0	172	0.00	4	802	0.50
75	1	131	0.76	0	140	0.00	2	127	1.57	2	95	2.11	5	493	1.01
76	1	211	0.47	1	204	0.49	1	214	0.47	1	162	0.62	4	791	0.51
77	1	103	0.97	2	165	1.21	3	155	1.94	0	132	0.00	6	555	1.08
78	0	5	0.00	0	136	0.00	1	204	0.49	2	188	1.06	3	533	0.56
79				0	6	0.00	0	140	0.00	1	201	0.50	1	347	0.29
TOTAL													23	3521	0.65

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=SUBCOMPACT DR_AGE=60+

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	1	55	1.82	2	66	3.03	0	64	0.00	0	57	0.00	3	242	1.24
75	0	31	0.00	0	26	0.00	0	43	0.00	0	30	0.00	0	130	0.00
76	1	50	2.00	1	48	2.08	1	58	1.72	1	57	1.75	4	213	1.88
77	0	23	0.00	1	48	2.08	0	42	0.00	0	39	0.00	1	152	0.66
78	0	3	0.00	0	35	0.00	0	40	0.00	0	51	0.00	0	129	0.00
79							0	38	0.00	0	48	0.00	0	86	0.00
TOTAL													8	952	0.84

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=ECONOMY IMPORT   DR_AGE=<23

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	14	848	1.65	29	1105	2.62	22	1029	2.14	10	816	1.23	75	3798	1.97
75	7	519	1.35	9	548	1.64	5	499	1.00	4	443	0.90	25	2009	1.24
76	10	867	1.15	10	974	1.03	12	932	1.29	9	711	1.27	41	3484	1.18
77	2	687	0.29	9	987	0.91	5	797	0.63	9	723	1.24	25	3194	0.78
78	0	21	0.00	2	785	0.25	10	1120	0.89	6	870	0.69	18	2796	0.64
79				0	12	0.00	2	855	0.23	15	1163	1.29	17	2030	0.84
TOTAL													201	17311	1.16

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=ECONOMY IMPORT DR_AGE=23-39

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	5	932	0.54	9	1090	0.83	13	1014	1.28	3	884	0.34	30	3920	0.77
75	2	556	0.36	5	577	0.87	6	606	0.99	3	519	0.58	16	2258	0.71
76	8	957	0.84	9	1034	0.87	9	1028	0.88	7	927	0.76	33	3946	0.84
77	3	663	0.45	4	1046	0.38	4	1077	0.37	12	978	1.23	23	3764	0.61
78	0	27	0.00	3	854	0.35	6	1373	0.44	11	1350	0.81	20	3604	0.55
79				0	25	0.00	3	999	0.30	6	1651	0.36	9	2675	0.34
TOTAL													131	20167	0.65

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=ECONOMY IMPORT DR_AGE=40-59

	1977			1978			1979			1980			ALL YEARS		
MODEL YEAR	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%	TIRE DEFECT	TOTAL	%
74	5	225	2.22	3	241	1.24	1	222	0.45	1	230	0.43	10	918	1.09
75	2	139	1.44	1	131	0.76	2	132	1.52	2	113	1.77	7	515	1.36
76	2	228	0.88	0	253	0.00	0	249	0.00	1	194	0.52	3	924	0.32
77	0	143	0.00	2	286	0.70	2	240	0.83	1	260	0.38	5	929	0.54
78	0	8	0.00	0	189	0.00	3	294	1.02	1	312	0.32	4	803	0.50
79				0	7	0.00	0	250	0.00	0	400	0.00	0	657	0.00
TOTAL													29	4746	0.61

TIRE DEFECTS FOR CARS
NC 1977-1980 REPORTABLE ACCIDENTS

SIZE=ECONOMY IMPORT   DR_AGE=60+

MODEL YEAR	1977 TIRE DEFECT	1977 TOTAL	1977 %	1978 TIRE DEFECT	1978 TOTAL	1978 %	1979 TIRE DEFECT	1979 TOTAL	1979 %	1980 TIRE DEFECT	1980 TOTAL	1980 %	ALL YEARS TIRE DEFECT	ALL YEARS TOTAL	ALL YEARS %
74	0	48	0.00	0	62	0.00	1	76	1.32	2	60	3.33	3	246	1.22
75	0	32	0.00	0	41	0.00	0	40	0.00	0	36	0.00	0	149	0.00
76	0	39	0.00	0	76	0.00	0	50	0.00	0	50	0.00	0	215	0.00
77	0	36	0.00	0	61	0.00	1	62	1.61	1	74	1.35	2	233	0.86
78	0	2	0.00	0	49	0.00	0	52	0.00	0	76	0.00	0	179	0.00
79				0	1	0.00	0	39	0.00	0	80	0.00	0	120	0.00
TOTAL													5	1142	0.44