AGE and SEX in RELATION to ACCIDENTS

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A PROPER analysis of any problem is essential to an adequate solution. It seems that the problems of age and sex in relation to automobile and traffic accidents have been grossly confused, due partly to the emotionality of writers on the subject.

The two are inseparable, since vast differences between the sexes are noted at various age levels. It is unintelligible to speak of the problems concerning one without a proper clarification of the limits of the other.

In order to treat an ailment, the doctor must find the origin of it or the part affected. Medication for eczema is not likely to help one with arthritis. Too often we try to reduce accidents by shot-gun remedies. Until the causes and those responsible for most of the trouble are singled out the proper methods of accident reduction cannot be determined.

The purpose of this paper is primarily to untangle some of the faulty conclusions that have been widely discussed about youthful drivers, women drivers, and older drivers. It is also hoped that it may stimulate greater care in coding the exact ages of drivers by the state licensing bureaus. Unfortunately, huge sums of money are spent annually in hoarding accident records and making compilations of simple tables, but little if any really scientific analysis is made of them. It is time that this practice is changed. We need to digest the results of accident reporting so that leads may be obtained which will be useful in educational,legislative, and enforcement circles to aid in accident reduction.

A very important aspect of the problem is the uneven grouping of ages for comparative purposes. The terminologies used are even confusing. Writers of popular articles on "teen-age" drivers sometimes construe the term to include every age up to 25 years. One state was known to report that 3 percent of its licensed drivers were 20 and below and were having half the fatal accidents from 12 midnight until 6 a.m. A recheck of the files showed that nearly 8 percent of their licensees were 20 and below, since 20-year olds were classified with "teen-agers."

It was with the hope that some of these confusing issues might be cleared up that a 5-year study of age and sex has been undertaken at Iowa State College. The specific hypothesis set up as a basis of the present paper may be stated as follows: Reported accidents are distributed evenly throughout the driving population according to density of population, age, and number of licensees. A corollary hypothesis to be tested may be formulated as: Accidents are distributed evenly throughout the driving population on the basis of miles driven by each age group.

In addition, answers to the following questions are sought through various studies in progress: Are age trends in accident involvement,as

secured from the accident files, consistent? Are accident reports in a given community an index to its fatality record? Is reporting uniformly carried out within a state and is it in anyway associated with density of population? If the hypotheses set up are confirmed, what would be the most fruitful immediate approach to the motor-vehicle accident problem? If the hypotheses are rejected, where should we start to improve drivers?

It is obvious that, as a rule, shot-gun methods in education, engineering, or any other field of endeavor will be less effective than systematically planned and organized effort. The least that can be left to chance the better. It is assumed that accident reporting is impartially carried out with respect to sex and age groups within a given municipality, state or territory.

METHOD AND PROCEDURE

This study was undertaken in cooperation with the Department of Public Safety in Iowa, the data presented being from Iowa. Continuation studies in cooperation with the motor-vehicle departments of Illinois, Minnesota, and Pennsylvania are now in progress and will be presented at a later time.

The method is of statistical and analytical nature and consists of drawing a systematic sampling of the drivers' license files in the state by examining and tabulating the data from every two-hundredth card of the 1,300,000 licenses in the state. The cards are jacketed and contain information on all accidents, violations, and revocations made by the licensee since the drivers license law became effective in Iowa in 1933. Overload and nonmoving violations were not included, since they may not be the fault of the driver. It is the information of the writer that standing violations, such as parking tickets, are not entered in the records.

It suffices to say that the reporting system developed gradually, as in other states, and that reporting became more efficient as the patrol was increased and more attention was given to accident reporting by the local traffic courts and enforcement agencies. Consequently, the increased number of accidents reported does not necessarily serve as a true index of the total number of accidents occurring within a given period. This is shown by the sharp jump in 1948 when the financial-responsibility law went into effect, as shown in Table 3.

After the list of 7,692 cases comprising the sample of licenses used in this study was drawn and prepared, a double, specially printed postcard was sent to each person requesting further information regarding the mileage driven annually by day and night. Other questions were asked about the way the person learned to drive, mileage on the car, age of car, model, ownership of car, and certain other related data. Only items referring to age, licensure, mileage, violations, and accidents will be reported here as taken from the state records.

The data were assembled and punched on IBM cards for analysis by age groups, sex, and location and according to mileage driven annually. Accidents, violations, age, and personal data were taken from state files. The data were recorded by years of age to the nearest birthday, but only accidents and violations for the years 1948 and 1949 were considered in this

study, due to the lack of consistency prior to that date (see Table 3.)

RESULTS

It was first considered necessary to make an estimate of the number of potential drivers in a state the size of Iowa for each age group. This is shown in Table 1 and was based upon 1940-census figures. The 1950-census data were not available at the time, and it was further considered that the percentage change would not likely be significant as it may well represent certain parameters of the population for the various age levels.

TABLE 1

STRUCTURE OF THE DRIVING POPULATION
(Estimates based on U.S. Census)

Age	Population Men	Licensed Women	Licensees Men	Mileage Index	Licensees Women	Mileage Index
	%	%	%		%	
15	7.7	0.9	0.234	32	0.026	10
16	20.0	3.8	0.624	42	0.117	14
17	60.9	11.7	1.651	58	0.351	16
18	67.0	25.8	2.145	73	0.845	18
19	63.5	18.2	1.885	89	0.559	20
20	54.9	17.4	1.573	99	0.533	22
21	56.1	15.7	1.651	105	0.468	23
22	48.2	26.1	1.352	114	0.767	25
23	68.6	15.1	1.991	121	0.442	27
24	76.9	17.0	2.158	127	0.494	28
25	67.8	24.8	1.924	124	0.741	29
26	69.0	23.5	1.911	131	0.676	30
27	68.7	30.8	1.859	138	0.845	31
28	71.6	29.6	1.950	136	0.845	31
29	61.2	21.7	1.612	130	0.585	32
30	72.2	22.5	2.054	129	0.676	33
31	67.5	23.5	1.586	126	0.559	33
32	67.7	19.4	1.794	123	0.533	34
33	66.4	20.9	1.586	121	0.507	34
34	67.5	19.7	1.638	118	0.468	35
35	55.7	19.4	1.430	116	0.507	36
36	55.4	23.6	1.547	114	0.559	37
37	66.9	28.7	1.638	112	0.637	37
38	60.2	27.9	1.391	111	0.676	39
39	57.7	25.6	1.404	112	0.624	40
40	54.1	28.5	1.430	109	0.663	41
41	67.2	42.9	1.261	109	0.780	41
42	57.4	20.4	1.365	108	0.481	43
43	62.7	25.0	1.326	108	0.520	44
44	60.0	26.0	1.222	108	0.520	46
45	54.4	24.6	1.274	108	0.624	47
46	60.3	19.2	1.222	108	0.364	48
47	68.6	23.9	1.417	108	0.468	49
48	65.2	21.8	1.389	109	0.429	50

TABLE 1 - continued

Age	Population Licensed Men	Women	Licensees Men	Mileage Index	Licensees Women	Mileage Index
	%	%	%		%	
49	50.7	25.4	1.001	109	0.533	50
50	55.7	26.4	1.261	108	0.494	50
51	63.6	27.4	1.066	108	0.416	50
52	52.4	21.8	1.053	109	0.403	50
53	64.5	31.5	1.092	107	0.494	49
54	79.4	37.0	1.365	106	0.598	47
55	60.1	23.4	1.014	105	0.377	46
56	62.8	20.5	0.988	104	0.299	43
57	77.5	24.6	1.092	102	0.325	40
58	65.7	12.6	0.975	100	0.182	35
59	65.3	21.2	0.845	96	0.273	32
60	67.3	21.4	0.871	92	0.286	30
65	66.9	21.4	0.728	75	0.234	23
70	57.8	23.8	0.433	71	0.182	18
75	45.7	8.8	0.208	70	0.043	15
80	65.8	4.6	0.164	69	0.001	12
85	61.4	0.0	0.060	61	---	--
90	81.4	0.0	0.020	50	---	--

Table 1 contains the fundamental data necessary to graph or otherwise convert accident frequencies into meaningful form. At times trends are real, even though statistical evaluations at any one point along the curve may not show a significant difference. Experimental or sampling errors may account for occasional deviations which, on first consideration, seem out of line, and thus false conclusions regarding trends may be drawn.

Comparison may be made from this table at any age up to 60, then by 5-year intervals up to age 90. The number of drivers in a given age group in Iowa may be closely estimated by sex, also the percentage at each age level that are licensed, and the percentage of all licenses in the state held by any age group. The stated annual mileage as obtained from a poll of the sampling drawn is given by the mileage index. This indicates the nearest number in hundreds of miles.

From such a table it is possible to group ages in any fashion desired and fairly reliable estimates may be made from the results. Unless the basic constants are approximately known, no valid conclusions can be drawn from accident figures.

Another source of error commonly found is anachronism. A certain group may be studied along with others of different ages. One individual may be noted for his accident record. It may be found that he has had six accidents. No account is made of when he had them, at what age or over what period of time. Table 2 shows data on male drivers plotted as of the age they were when the accident occurred. Conditions no doubt change. By taking all accidents occurring at a given age for several years we get a better estimate of the performance of a given age level. That the reporting

index at least changes during a period of time is shown in Table 3. Thus a cross-section study over several years is probably more meaningful than any short-time study, as long as correction is made for the age at which accidents occur.

TABLE 2

REPORTED ACCIDENTS ALL AGE GROUPS[a]
(Male Drivers)

(Based on a preliminary tabulation of 1,806 accidents from cases drawn.)

Age	Percent	Age	Percent	Age	Percent	Age	Percent
13	0.0574	35	1.4917	57	0.6885	79	0.2295
14	0.0574	36	2.1801	58	1.0901	80	----
15	1.1474	37	1.8360	59	0.8032	81	0.1147
16	2.0080	38	1.9507	60	0.4590	82	0.0574
17	3.0981	39	2.0080	61	0.5164	83	0.0574
18	3.4997	40	1.5491	62	0.3442	84	----
19	4.1882	41	1.6638	63	0.8032	85	----
20	3.6145	42	1.7785	64	0.2870	86	----
21	3.6718	43	1.8360	65	0.5164	87	----
22	4.3603	44	1.2622	66	0.2870	88	----
23	3.2702	45	1.6638	67	0.2870	89	0.0574
24	3.4997	46	1.5491	68	0.4590	90	----
25	3.7866	47	0.9753	69	0.4590	91	----
26	4.1882	48	0.7458	70	0.1721	92	----
27	3.2129	49	1.3769	71	0.5164	93	----
28	3.3850	50	1.0327	72	----	94	----
29	2.2375	51	0.8032	73	0.1721	95	----
30	2.2950	52	1.2048	74	0.0574	96	----
31	2.6391	53	0.9753	75	0.0574	97	----
32	1.7785	54	1.0901	76	0.1721	98	----
33	2.0080	55	0.8606	77	0.1147	99	----
34	2.1801	56	1.0327	78	0.1721		

a/ - Represents part of sampling of every 200th card of all accidents reported to the state from 1933-1950 inclusive to March 1950. Tabulated by age at the time they were reported.

TABLE 3

ALL ACCIDENTS AS REPORTED BY YEARS IN IOWA
(Male Drivers)

Year	Percent	Year	Percent	Year	Percent
1930	------	1937	1.3196	1944	3.4997
1931	------	1938	2.3523	1945	4.3029
1932	------	1939	4.0161	1946	0.3442
1933	------	1940	5.3930	1947	8.6059
1934	------	1941	5.9667	1948	29.2025[a]
1935	------	1942	4.4177	1949	27.0787
1936	0.0574	1943	3.3276		

a/ - Financial Responsibility Law enforced after January 1, 1948.

Our first hypothesis set up for testing may be considered at this time. Since temporal distribution of reporting varies, what may be expected of spatial reporting? Within a state, is reporting quite uniformly carried out throughout the different districts, counties and population areas? A statistical evaluation of approximately equal population groups in Iowa combined according to population are presented in Table 5.

TABLE 4

DISTRIBUTION OF ACCIDENTS ACCORDING TO DENSITY OF POPULATION

Group	Number of Counties	Accidents		X^2
		Actual	Expected	
I	1	220	111.5	70.336[b]
II	2	124	102.9	4.317[a]
III	3	140	133.2	.342
IV	5	126	127.5	.018
V	5	94	98.3	.190
VI	8	83	105.8	4.938[a]
VII	10	96	109.0	1.557
VIII	10	88	100.2	1.484
IX	11	106	98.0	.646
X	12	73	95.8	5.423[a]
XI	15	88	116.7	7.057[a]
XII	17	77	95.9	3.736

a/ - Significant at the 5-percent level.
b/ - Significant at the 1-percent level.

The Roman numerals consist of counties grouped together to give approximately equal populations. These were theoretically equated as given in the "expected" columns. In general, the Roman-numbered groups average around 200,000 and it may be fairly easy to estimate the population of individual counties by dividing the number of counties into 200,000. Iowa has 99 counties which average around 1,000 sq. mi. in area each.

By studying the table it will be noted that discrepancies exist between expected values and observed values. The chi-square index is an evaluation of the significance of the discrepancies. A chi-square above 3.841 indicates a 5-percent level of confidence. Above 6.635 it shows a confidence level of 1 percent. Higher values show correspondingly greater probabilities of significance. It is to be noted that densely populated areas show an excess of reported accidents while sparsely settled counties show a deficiency. No speculations as to the reasons for this will be made here.

Next it seemed advisable to consider fatalities occurring within these areas since it is generally considered that accidents and fatalities are correlated, although fatalities are much more reliably reported. Table 5 shows the results obtained from this analysis.

By such technique we may set up any hypothesis that appears reasonable and check for correspondence with observed values. It might have been more logical to have used fatalities as the criterion or basis of comparison, but the results would be very similar in either case. From it we see that there

is very little correspondence between the accident-reporting index and the fatality index of similar population groups with the geographical size of area varying. A further study of reasons for this observation is being made.

TABLE 5

RELATION BETWEEN REPORTED ACCIDENTS AND FATALITIES BY AREAS USING ACCIDENTS AS THE CRITERION

Group	Number of Counties	Accidents		X^2
		Actual	Expected	
I	1	150	344.59	109.885
II	2	138	203.40	21.028
III	3	217	232.83	1.076
IV	5	194	203.40	0.436
V	5	138	159.82	2.979
VI	8	182	136.59	13.168
VII	10	216	153.67	25.282
VIII	10	205	155.22	15.965
IX	11	175	180.09	0.144
X	12	206	127.28	48.687
XI	15	203	152.12	17.018
XII	17	160	135.04	46.135
		Total chi square		301.803

This table shows the incidence of accidents at different age levels for men. It is quite obvious that the trouble spot here lies with ages 18 to 23 inclusive. Ways and means of dealing with this group of drivers must be evolved.

TABLE 6

SIGNIFICANCE OF DIFFERENCES FOUND IN REPORTED ACCIDENTS AT VARIOUS AGE LEVELS - MEN. EQUATED FOR MILEAGE

Age	Accidents		X^2
	Actual	Expected	
15-17	24	16.85	3.085
18-20	103	62.85	27.324[b]
21-23	117	72.74	28.988[b]
24-26	116	99.22	3.142
27-29	103	96.32	0.498
30-32	78	87.12	1.043
33-35	52	71.64	5.789[a]
36-38	64	66.86	0.131
39-41	50	58.13	1.205
42-44	48	55.06	0.956
45-47	46	55.12	1.595
48-50	37	49.44	3.289
51-53	33	45.01	3.352
54-56	29	46.03	6.589[a]
57-59	27	37.63	3.117
60 & over	98	104.97	0.468

a/ - Significant at the 5-percent level.
b/ - Significant at the 1-percent level.

Such techniques may also be used to spot areas of poor enforcement, low accident-reporting indices, or other conditions affecting highway safety. They may be useful in diagnosing the conditions related to the incidence of accidents and fatalities. A great deal of valuable information on the causes of accidents by repeated comparisons could be gained. The method with some modification may be valuable in solving certain problems of traffic engineering.

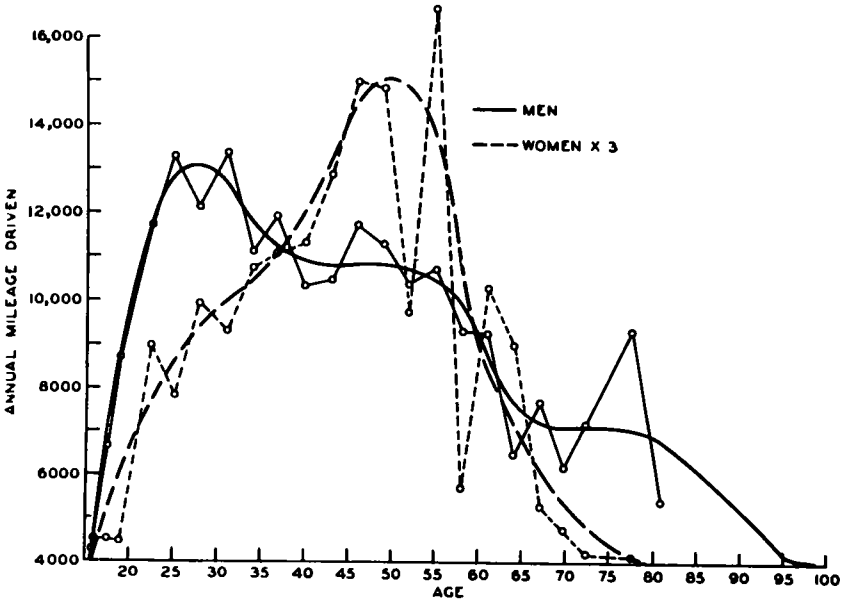

Figure 1. Relation between age and annual mileage driven (from sample of 7692 Iowa drivers; curves based on 1,419 cases replying).

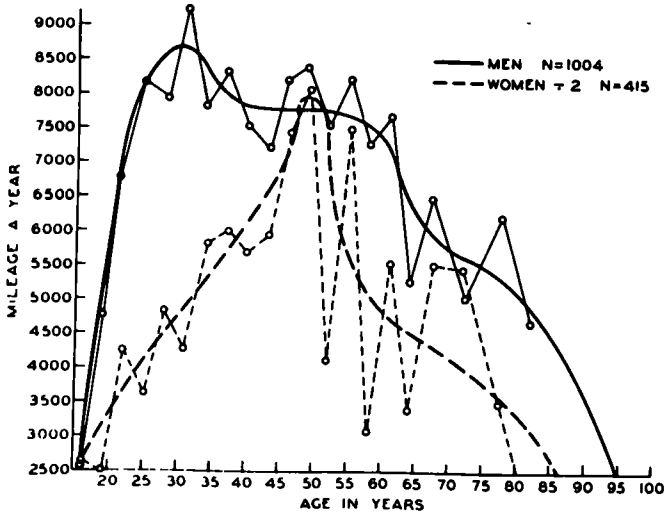

Figure 2. Relation between age and daylight driving mileages.

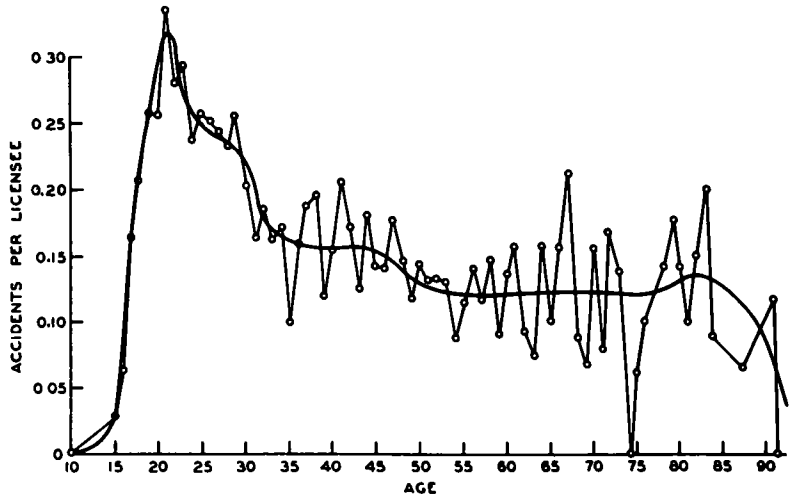

Figure 3. Accidents per licensee (1948-1949; male drivers; Iowa)

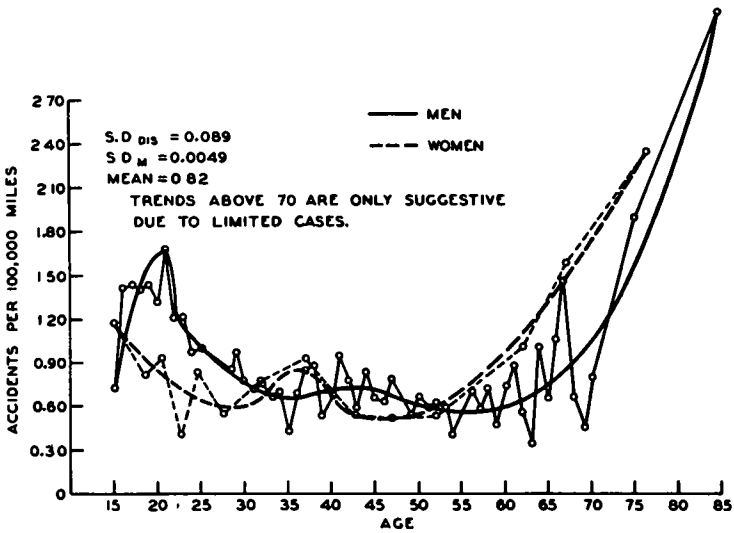

Figure 4. Accidents per 100,000 mi. (at different age levels).

These figures are more or less self-explanatory. Figures 1 and 2 show distributions of the reported mileage driven by men and women at all driving ages. The first shows annual mileage while the second indicates daylight-driving mileage. By deriving a third curve it would be possible to secure estimates of night driving at different age levels. Since a satisfactory grouping of data could not be secured for night driving, it was decided to make a separate analysis of this aspect of the youthful driving problem.

Figure 3 shows a smoothed curve of all the accidents reported for men during 1948-49 irrespective of mileage. The index is much higher for these two years than it was for any previous years as shown by Table 3.

Figure 4 shows the results obtained from plotting mileage-corrected accident indices for all age groups of men and women. It is to be noted that the index curves for men and women cross each other several times. The wider points of separation are significant. Again it must be cautioned that the mileage characteristics will likely change from year to year and such data must be kept up to date to be useful.

GENERAL SUMMARY AND CONCLUSIONS

A study of 7,692 Iowa drivers sampled from the drivers license files was made to answer two fundamental questions: Are reported accidents equally distributed among the population, age and number of licensees? Are accidents distributed equally among licensed drivers when mileage is held constant?

A number of secondary questions were posed, the answers to which may be summarized in the following conclusions subject to the nature and limitations of the study:

1. There is a preponderance of evidence that male drivers 30 and under contribute very heavily to the accident total. The differences from 18 to 23 are highly significant.

2. Male drivers spend 5 years before improvement in their reported accident record appears. Women improve their records from the beginning of their driving period.

3. Women differ from men at various age levels with respect to accidents reported against them. They drive much fewer miles a year than men and hold only about 25 percent of the licenses. They do about 10 percent of the driving and have about 9 percent of the accidents reported to the state. The chi-square test of men's and women's reported accidents was not significant, being 1.818, with a slight advantage in favor of women.

4. There is little correspondence for equal population areas, graded from most-dense to least-dense populations, between reported accidents in these areas. There tends to be an excess of accidents reported in larger cities and deficiency of reporting in sparsely settled districts, counties and areas.

5. The techniques used are suggested for spotting various conditions and situations which may be related to highway accidents.

6. Both the primary and corollary hypotheses set up for testing are rejected and the results would suggest a careful analysis of accident conditions within a state be made and used as the basis for a systematic highway accident reduction program.

7. One of the most serious problems is that of youthful male drivers. Whether the answer is probational licenses, driver education, closer surveillance and stricter enforcement, governors on cars, or other means is beyond the realm of this investigation. It appears that something will need be done, since a reasonable estimate would indicate the reduction of at least 10 percent in automobile fatalities by bringing accidents of men below 30 down to the average of other ages.

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