New York State used the home interview technique to gather data for determining accident rates for a sample of motor vehicle drivers in Saratoga Springs. From this preliminary study, we learn that it is possible—if the data are sufficient and the population is well defined—to obtain reliable rates on which to base future accident prevention activities.

An Epidemiological Approach to Traffic Accidents

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MOST traffic accidents are apparently due to errors in the decisions of drivers rather than to defects in the motor vehicle or hazards present on the road. It has been estimated from analyses of accident reports that 75 to 90 percent of all traffic accidents can be attributed to human error (*1*). Although accident report data are admittedly not entirely reliable, particularly with regard to the designation of human error as the responsible factor, it remains likely that some large portion of automobile accidents result from miscalculation by the driver.

There is considerable evidence which suggests that several characteristics of the driver are associated with a high risk of involvement in the accident. Persons with high levels of alcohol in the blood have been found to be involved in accidents more frequently than those without such levels of alcohol (*2*, *3*). Individuals who become involved in accidents repeatedly have been characterized as accident prone although the permanence of this characterization is uncertain (*4*). A variety of driver selection studies by commercial and military agencies have tested intelligence, speed and accuracy of perception, learning of coordination, and certain attitudes (*1*). When accident reports from general populations are analyzed according to age, it has been found that young persons between 18 and 25 have a disproportionately high number of accidents (*5*).

To Identify the Hazardous Driver

The many procedures that have been employed have met with varying success in the

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attempt to identify individuals with a greater likelihood of becoming involved in accidents. The aim common to all such efforts is to identify the hazardous driver in order to exclude him from the driver population, at least until he has been successfully retrained. With few exceptions, however, the evidence supporting these means for detecting hazardous drivers has apparently not been sufficiently convincing to warrant general acceptance as screening procedures by official agencies charged with licensing drivers. This lack of acceptance may be due in part to the nature of the attributes chosen for study or to the particular methodology of the study. Whatever the reason, the result has been that the findings cannot easily be applied to the general population.

The New York State Department of Health thought it worth while to attempt to apply the epidemiological approach to a study of traffic accidents. Consultations with traffic authorities lent encouragement to the plan and also provided essential technical advice. Close sociologic supervision was supplied throughout all stages of the planning and operation of the study. Special attention was given to interviewing techniques and sampling of the population.

The epidemiological method consists essentially, first, of grouping the members of a general population according to well-defined characteristics, such as age, sex, occupation, and, where possible, exposure to the event or disease under study; and, second, of determining the proportion of the groups that experiences the event or becomes ill. This information is useful in order to determine how a disease starts or where it exists in a community, how it spreads, and where control measures should be applied.

The epidemiological approach has proved of value in the control of many diseases—occupational diseases are an example. An epidemiological study, therefore, of certain attributes of the driving population of a community holds promise for ascertaining whether the traffic accident problem is in reality largely one of human behavior.

Figure 1. Proportion of adult population who are drivers, according to age and sex.

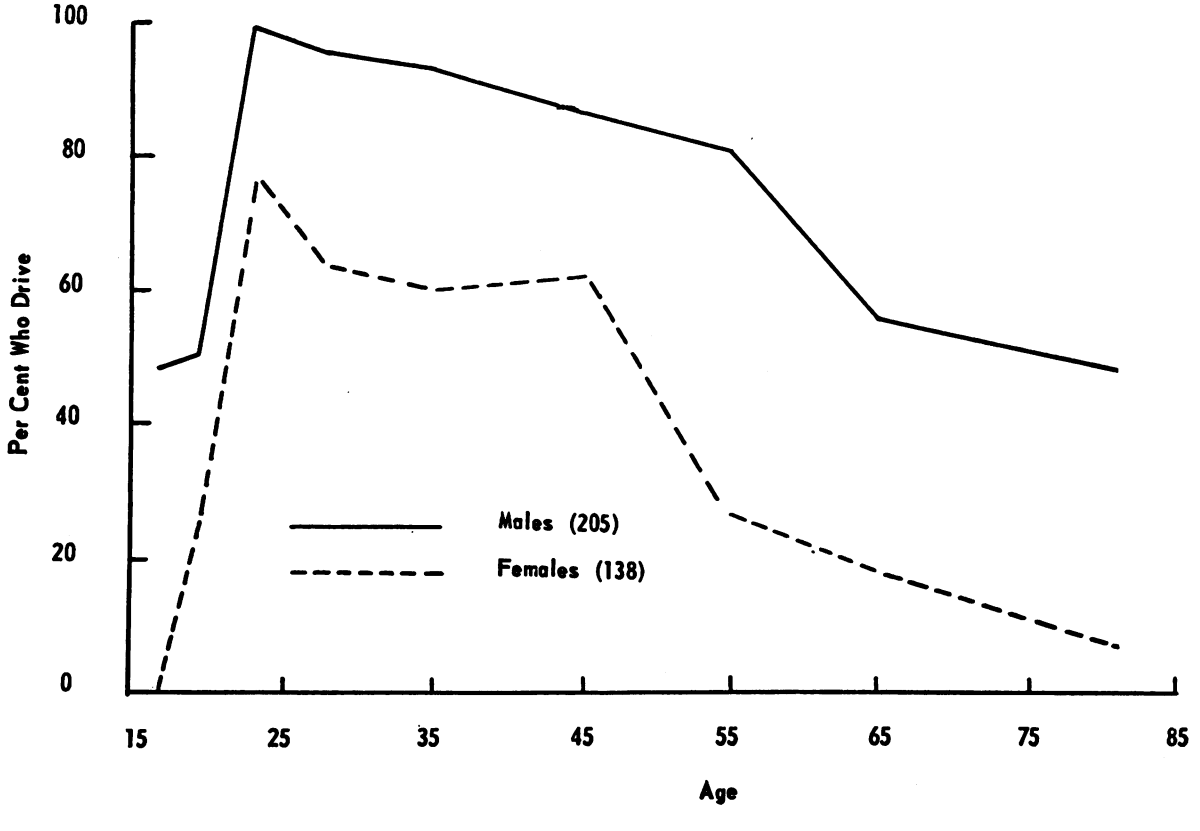
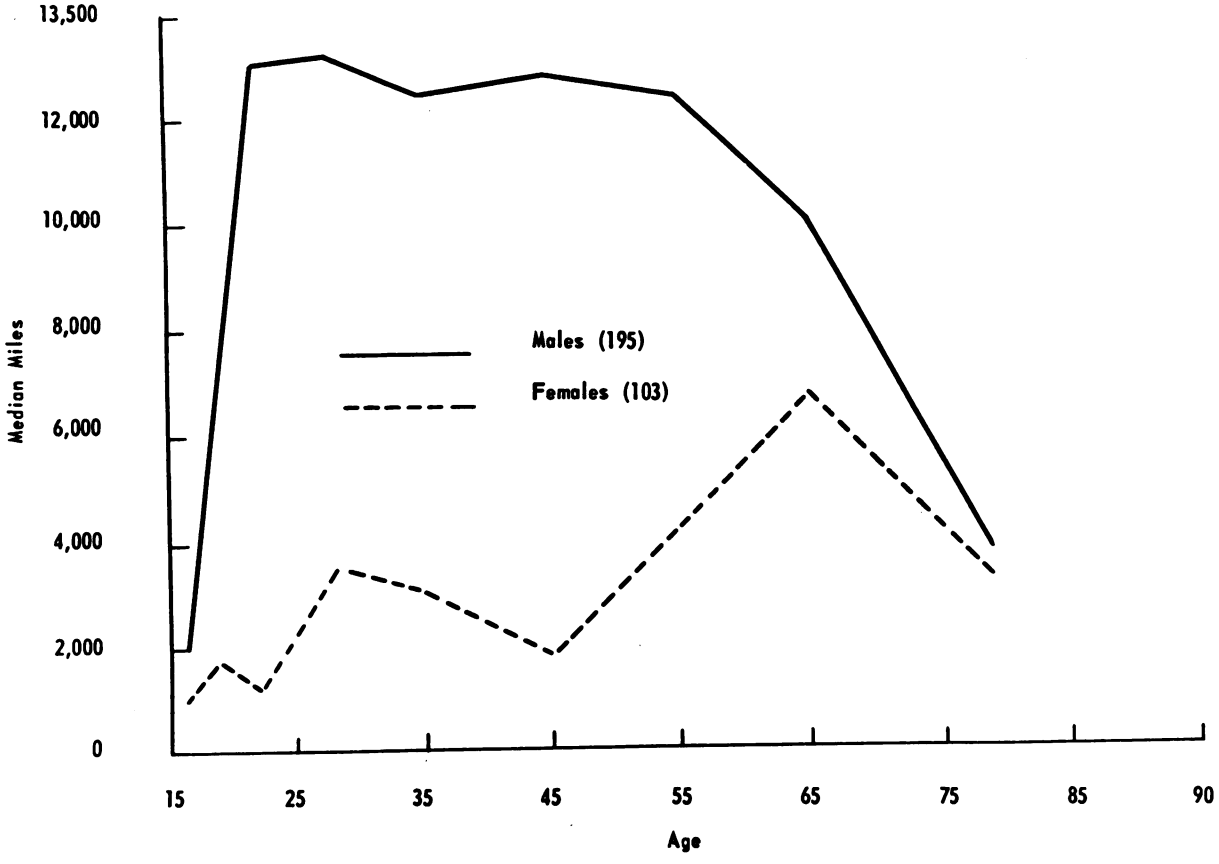


Figure 2. Exposure to traffic accidents in terms of the median miles driven during preceding year, according to age and sex.



This report presents some of the data obtained in the health department's exploratory study in traffic accident epidemiology. In the hope of stimulating critical interest, illustrations of some of the techniques that were employed are presented in the form of graphs or tabulations.

The Sampling Techniques

Our investigation was made during a 3-week period of clear weather in late November and early December 1953 at Saratoga Springs, N. Y. The population studied consisted of a sample carefully selected in the hope that it would be representative of the city and the surrounding natural trading area, a zone of approximately 5 miles. The sampling procedure was one of assigning consecutive numbers to all blocks on a map of the city and to all segments of the rural area, and, then, by reference to a table of random numbers, of choosing a sample of blocks and segments to be studied. Every fourth household of each sample block or segment was assigned for interviewing.

An attempt was made to interview all individuals 15 years and older in the study population. Children under 15 were enumerated only. Interviews were successfully obtained with 563 of the 637 individuals in the study group but not with 74 persons, most of whom were not at home on repeated visits. Seventeen declined to be questioned. The 74 individuals who fell in our theoretical sample, but who were never interviewed, do not form a part of the study population.

The interviewing was handled by 9 biostatisticians, 2 physicians, and 1 cultural anthropologist, all from the health department. Twenty-nine sociology students at Skidmore College assisted. To assure consistency in the use of interview techniques, each interviewer was given several hours of training. Interview questions had been pretested in the city of

Table 1. Sources of data and severity of accidents occurring to drivers in the study population

Source of data	Number of drivers	Severity			
		Fatal	Personal injury	Property damage	Severity not known
Total	25	1	1	13	10
Interview and motor vehicle bureau file	10	1	1	8	------
Interview alone	9	-----	------	------	9
Motor vehicle bureau file alone	6	-----	------	5	1

Oneonta with the assistance of sociology students in the Oneonta State Teachers College.

Information was sought on a variety of subjects that can be described briefly as identifying information, exposure to traffic accidents, driving experience in number of years of driving, description of automobile trips on the day before the interview, health status, income, occupation, involvement in a traffic accident occurring earlier in 1953, and some opinions on the driving regulations and traffic problems of Saratoga Springs.

Some of the Findings

Examination was made of the study population by age and sex, according to whether or not the respondent drove a motor vehicle. In all age groups a considerably larger proportion of men than women are drivers, it was found. This finding is illustrated in figure 1, which also shows a steady decline in the proportion of drivers with increase in age. Of the persons interviewed, 264 were men and 299 were women. Seventy-eight percent (205) of the men and 42.5 percent (138) of the women were drivers.

Exposure to traffic accidents was determined in terms of the number of miles that the individual stated he had driven during the preceding months in 1953. The variations in exposure by age and sex are shown in figure 2.

The median number of miles driven per year varies from 1,200 miles (women, 21–24) to more than 13,000 miles (men, 21–29). It can be seen from the figure that the line for women is consistently below that for men, although several points on the curve are based on only a few observations.

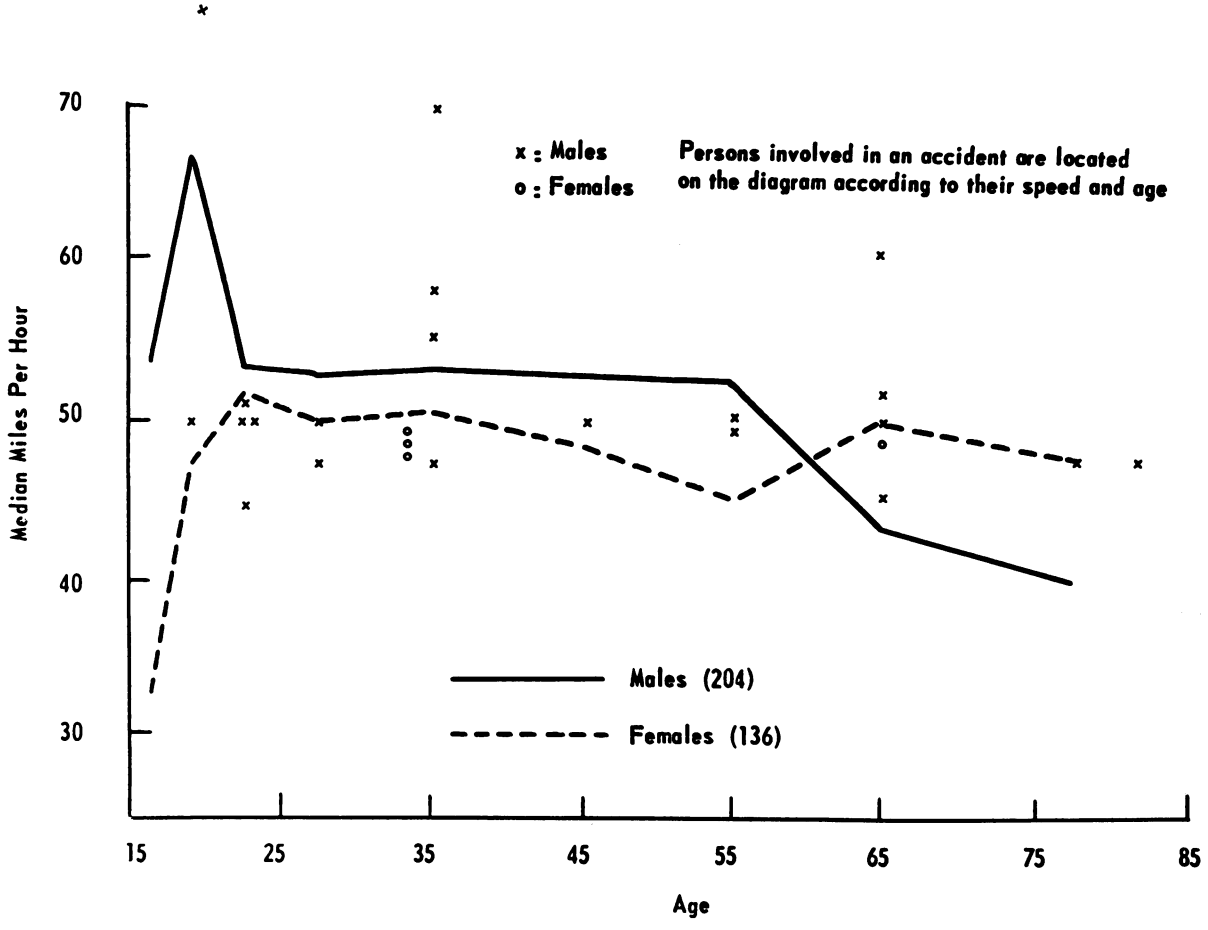
Twenty-five members of the study population had been involved in automobile accidents during the 11-month period between January 1 and

Table 2. Accident rates for the study population according to age, sex, and exposure in terms of median miles driven during 11 months, 1953

Age group	Men					Women				
	Median miles per year (a)	Number of drivers (b)	Total miles (c)	Number of drivers in accident (d)	Accident rate (e)	Median miles per year (f)	Number of drivers (g)	Total miles (h)	Number of drivers in accident (i)	Accident rate (j)
Total	11, 400	208	2, 375, 000	21	8. 8	2, 800	138	380, 000	4	10. 5
15–17	2, 000	8	16, 000	--------	--------	1, 000	1	1, 000	--------	--------
18–20	7, 500	4	30, 000	2	66. 7	1, 700	7	12, 000	--------	--------
21–24	13, 100	17	223, 000	4	17. 9	1, 200	11	13, 000	--------	--------
25–29	13, 300	24	320, 000	2	6. 3	3, 500	25	88, 000	--------	--------
30–39	12, 500	48	600, 000	4	6. 7	3, 100	43	132, 000	3	22. 7
40–49	12, 900	40	514, 000	1	1. 9	1, 900	28	53, 000	--------	--------
50–59	12, 500	29	363, 000	2	5. 5	4, 300	13	55, 000	--------	--------
60–69	10, 000	21	210, 000	4	19. 0	6, 700	8	53, 000	1	18. 7
70–89	3, 500	14	54, 000	1	18. 4	3, 500	2	7, 000	--------	--------
Not stated	--------	3	----------	1	--------	--------	--------	--------	--------	--------

NOTE: Number of miles has been rounded off to nearest hundred. Accident rates were calculated from original figures.

Figure 3. Stated usual speed on open road.



(approximately) December 1, 1953. Data on the number of accident-involved persons and the severity of the accidents are presented in table 1. No distinction was made by our investigators between persons to blame or not to blame for their accidents, nor was the definition of a traffic accident elaborated on in any great detail.

The information about accidents was gathered from two sources: the interview and the New York State Bureau of Motor Vehicles.

In the interview the question was asked, "Have you by any chance been involved in an accident since January 1 of this year? I would like to know about all accidents regardless of whether or not it was your fault or how small it was." The respondent himself was depended on to determine what constituted a motor vehicle accident.

Search of the accident file of the bureau of motor vehicles over the 12-month period January 1 to December 31, 1953, corroborated 10 of the accidents reported by the respondents. However, six reports were found in the bureau file for accidents that were not reported during the interviews. Nine persons stated that they had been in accidents, but reports for these accidents were not found in the bureau file.

A portion of these individuals may have had accidents which occurred outside New York State or accidents which involved no other car. Some also were too minor to report on legal grounds since New York State law requires that reports be filed only for an accident that involves personal injury or property damage over $50. Details were not obtained about the accident during the interview, and, therefore, it is not possible to estimate the severity of the latter group of accidents. We did not expect to obtain as many accidents as we did from the interviews. We anticipated that the severity could be better measured by the official reports.

Accident rates are presented (table 2) according to age, sex, and exposure. In order to derive the rate, the median number of miles driven during the year of exposure (column *a*) was multiplied by the number of drivers in each age group (column *b*). The product (column *c*) represents the total exposure for an age group. The number of accident-involved persons (column *d*) is divided by the total exposure (column *c*) to obtain the accident rate per million miles of exposure (column *e*).

The limited size of the study material, as reflected in the small number of accidents, makes for unstable rates. This instability is especially apparent in the rates shown for women drivers. However, there is a suggestion in the data that men aged 25 to 59 experience lower accident rates than men of other ages.

Table 3. Accident rates for various driver characteristics, according to sex and exposure

Response	Men				Women			
	Number of drivers	Median miles per year	Number of drivers in accident	Accident rate	Number of drivers	Median miles per year	Number of drivers in accident	Accident rate
Alcohol consumption:								
Never drink	48	8, 800	5	11. 9	33	1, 600	----	----
Drink	159	12, 300	16	8. 2	104	3, 200	4	12. 2
Not stated	1	----	----	----	1	----	----	----
Body height-weight evaluation:								
Underweight	12	12, 500	1	6. 7	20	3, 000	1	16. 7
Normal weight	140	10, 900	15	9. 8	92	2, 800	2	7. 8
Overweight	55	12, 700	5	7. 1	24	1, 900	----	----
Not stated	0	----	----	----	2	----	1	----
Wearing glasses while driving:								
Wears glasses	67	11, 800	7	8. 9	49	2, 300	2	17. 7
Does not wear glasses	138	11, 500	14	8. 8	88	3, 000	2	7. 5
Not stated	3	----	----	----	1	----	----	----
Opinion on posted speed limits:								
Too low	29	15, 600	2	4. 4	7	1, 700	1	83. 3
Satisfactory	160	11, 800	19	10. 1	127	2, 800	3	8. 4
Too high	16	4, 300	----	----	1	1, 000	----	----
Not stated	3	----	----	----	3	----	----	----
Stated usual speed on road:								
30–40 m.p.h	17	2, 500	----	----	17	1, 100	----	----
40–50 m.p.h	51	10, 200	4	7. 7	51	3, 300	----	----
50–60 m.p.h	116	13, 500	14	8. 9	58	3, 900	4	17. 6
60–85 m.p.h	19	13, 100	3	12. 0	6	5, 000	----	----
Doesn't drive on open road	4	1, 000	----	----	2	1, 000	----	----
Not stated	1	----	----	----	4	----	----	----
Family income:								
Under $3,000	46	10, 000	4	8. 7	28	5, 000	1	7. 1
$3,000 to $5,000	92	10, 600	12	12. 3	61	2, 000	1	8. 4
$5,000 to $9,000	47	12, 700	4	6. 7	30	3, 700	----	----
$9,000 to $12,000	14	13, 300	----	----	6	1, 700	1	100. 0
$12,000 and over	3	12, 500	1	26. 3	3	3, 500	----	----
Not stated	6	25, 000	----	----	10	2, 000	1	50. 0
Where driving is done:								
City	99	10, 900	12	11. 1	75	2, 500	4	21. 3
Country	22	10, 500	1	4. 3	13	2, 000	----	----
Highway	8	17, 500	----	----	4	3, 000	----	----
Mixed	71	12, 200	8	9. 3	41	4, 400	----	----
Own property	3	1, 000	----	----	1	1, 000	----	----
Not stated	5	7, 500	----	----	4	1, 500	----	----

NOTE: Number of miles has been rounded off to nearest hundred. Accident rates were calculated from original figures.

Table 4. Miles driven according to the day of the week

Day of driving	Drivers interviewed	Drove day before interview		Mean miles per person driving
		Number	Percent	
Total	346	235	67.9	33.9
Sunday	66	48	72.7	41.6
Monday	58	37	63.8	17.6
Tuesday	58	44	75.9	42.5
Wednesday	58	40	69.0	26.3
Thursday	32	19	59.4	46.2
Friday	58	37	63.8	23.4
Saturday	16	10	62.5	32.9

The sharp difference in the number of miles driven by men and women is also brought out in table 2. By comparing column *a* with column *f*, we see that a man drives approximately four times as much as a woman. Coupled with this difference is the additional fact that there are more men drivers than women drivers, as shown in figure 1. Thus, for every mile driven by a woman (column *h*), there are 6 miles driven by a man (column *c*).

Some Additional Characteristics

The home interviews produced a variety of additional data. Much of this information would prove useful for further identification of hazardous drivers if the quantity of study material permitted. Several characteristics of drivers are presented (fig. 3 and table 3), to illustrate how a particular age and sex group with a high accident rate could be further analyzed according to such factors as drinking, habitual rural or urban driving, opinion on speed limits, usual speed of driving.

One of these characteristics, the usual speed driven, is diagramed in figure 3. Speeds that respondents said they usually drove on the open highway are plotted against age for both sexes. The line, in the figure, for women lies under the line for men in all age groups below age 65. By designating the 25 accident-involved individuals as *x* and *o* (*x* for men, *o* for women) on the diagram, we can see that accidents are distributed about equally above and below the median speeds. This distribution suggests that high-speed drivers and low-speed drivers experience a similar number of accidents. However, it should be pointed out that correcting the data for driving exposure and for the factor of the reliability of the statements on speed would provide a more accurate interpretation.

Examples of additional characteristics are shown in table 3. These topics presented no insurmountable problems in most of the interviews. Responses were usually given freely, with an effort to be accurate, to such delicate questions as drinking, income, previous driver license suspension—not shown in the table, but license suspension was admitted by 10 persons. The determination of income by interview of a sample in a population has been employed successfully, of course, in numerous sociologic surveys. Several questions were asked about the presence of a chronic disease or a disability—not included in the table either—but the small base population did not yield many individuals so afflicted.

Some examples of the activities which the drivers reported for the day before their interview are examined in tables 4–6. The question as to what trips were made yesterday (table 4), a query frequently used in origin-destination surveys, has been successfully applied to the analysis of traffic flow for the design of traffic arteries (*6*). A group of individuals identified as those who drank before driving was compared with a group who did not drive after drinking (table 5). The time of drinking was compared with the time of driving on that day, about which inquiry had been made earlier in the interview. From the inquiry about medications taken on the day before inter-

Table 5. Alcohol consumption on day before interview

Response	Number of drivers	Percent
Total	346	100.0
Did not drink	271	78.3
Drank	73	21.1
Drove after drinking	27	7.8
Did not drive after drinking	46	13.3
Not stated	2	.6

Table 6. Medications taken on day before interview

Medication	Number of drivers	Persons who drove yesterday		Persons who did not drive yesterday	
		Number	Percent	Number	Percent
Total	346	235	100.0	111	100.0
Antihistamine	5	3	1.3	2	1.8
Aspirin	13	8	3.4	5	4.5
Injected material	1	1	.4	0	0
Insulin	0				
Prescription	10	7	3.0	3	2.7
Sedative	0				
Tonic	4	2	.9	2	1.8
Vitamin	14	10	4.3	4	3.6
Other	4	4	1.7	0	0
Not stated	11	8	3.4	3	2.7
No medication	284	192	81.7	92	82.9

view (table 6), it is of interest that no substantial decrease in driving was observed for the 35 persons who took some type of medicine.

Many additional analyses were attempted of variables of interest in highway safety. Some of these analyses included these characteristics: speed by family income groups, number of trips made and number of passengers carried on day before interview, frequency of driving, time of driving, and stated usual speed on open road according to occupation. More extensive investigation is required to yield reliable information on these factors.

Validation of the Findings

Some characteristics of the study population were compared with those described for the Saratoga Springs area by the 1950 national census in order to see whether the sample studied was truly representative of the community. Close similarity between the sample and the actual population was found in the proportion of men and women, of nonwhites, and of individuals in gross age groupings, household size, occupation, and family income. In the inquiry about occupation, sufficient details were not obtained to permit classification of a professional driver group since the emphasis was placed upon a classification that could be compared with census data.

In an effort to measure validity, the results of the inquiry about age and driver status have been compared with data from another source. A comparison is shown in table 7 of the ages of drivers interviewed in the study and the ages of drivers licensed in upstate New York. The close similarity in the age structure of the two populations serves as evidence for reliability of the sampling and interviewing procedures employed in this study.

The accident rates computed for the data shown in table 3 are intended to illustrate method and cannot be considered stable. The stability of the computed rates was examined by determining the variation that exists in a random subgrouping of the sample. Rates were computed for subgroups according to their household numbers. Variation in rates among the subgroups was found to equal or exceed many of those in the data presented.

Validation of responses on each of the interview topics (table 3) is highly desirable before any inferences are to be drawn and should be done wherever possible in larger samples that may be studied. The validity of responses

Table 7. Composition of driving population in regard to age and sex and in comparison with a 1952 sample of licenses in the New York State Bureau of Motor Vehicles [1]

Age group	Driving population in study						Percentage of drivers licensed by bureau
	Men		Women		Both sexes		
	Number	Percent	Number	Percent	Number	Percent	
Total	205	100.0	138	100.0	343	100.0	100.0
15–17 [2]	8	3.9	1	0.7	9	2.6	1.2
18–20 [2]	4	2.0	7	5.1	11	3.2	4.3
21–24 [2]	17	8.3	11	8.0	28	8.2	7.7
25–29	24	11.7	25	18.1	49	14.3	12.4
30–39	48	23.4	43	31.2	91	26.6	25.5
40–49	40	19.5	28	20.3	68	19.8	20.9
50–59	29	14.1	13	9.4	42	12.2	15.6
60–64	12	5.9	4	2.9	16	4.7	5.5
65 and over	23	11.2	6	4.3	29	8.4	6.9

[1] The sample was taken from licenses of drivers registered with the bureau of motor vehicles in upstate New York.

[2] The age groups 15–24 years include 8 drivers without any license.

should be tested especially for the desire of the respondent to be accurate and his ability to supply accurate estimates of rather complex activities. The estimate of the number of miles driven during the preceding months in 1953 (fig. 2), for example, was difficult to determine for some individuals, particularly for some professional drivers and some housewives. Reliability and accuracy of the responses regarding exposure require further study.

The validity of the estimates of exposure that have been employed in the calculation of accident rates is of special interest. In the inquiry about the driving reported for the day before interview (table 4), approximately two-thirds (67.9 percent) of the drivers had driven an average of 34 miles on the day preceding their questioning. Variations are shown in the proportion of drivers who drove and in the mean number of miles driven according to the day of the week.

The number (33.9) of mean daily miles driven is in close agreement with the estimated annual exposure of 7,750 miles for the members of the study population (this estimate was determined from the data presented graphically in figure 2) and compares well with the national average of 7,800 miles estimated for 1953 (*7*).

The agreement can be demonstrated in this fashion: If 33.9 miles are driven daily by 67.9 percent of the study population, then the entire group of drivers drives an average 23 miles a day. Multiplying 23 by 365 (the number of days in a year) yields approximately 8,400 miles for an estimated year of driving.

Discussion of Values

The foregoing material illustrates methods for gathering and assaying epidemiological data about selected characteristics of automobile drivers that may be of importance in contributing to traffic accidents. The data also serve as a basis for estimating the amount of study material needed to determine reliable accident rates according to relatively well-defined characteristics in the general population. On the basis of these preliminary results, we consider the epidemiological approach applicable to a study of traffic accidents.

The validity of several steps in the application of the method to traffic accidents has been reviewed. To summarize briefly, the sampling procedures employed yielded a population whose attributes were comparable with those described in the 1950 census and also were comparable, with respect to age, to a sample of driver licenses issued by the State bureau of motor vehicles. Inquiry concerning exposure to traffic accidents was found to yield results comparable with data from other sources.

In addition to serving as an illustration of the epidemiological method, some points in this report mark out unequivocal differences in driving experience and exposure in the general population. Almost twice as many men (78 percent) as women (42 percent) drive an automobile. The exposure to traffic accidents in number of miles driven per year for men is approximately 6 times that for women. Marked age-sex differences are seen, both in the proportion of drivers and the amount of annual driving done in a year. Such variations as these offer strong argument for a critical examination of various groups within the driving population as one phase in the search for hazardous drivers.

A measure of the reliability of obtaining accident reports in interviews is apparent from the data shown in table 1. Only some two-thirds of the individuals questioned related the story of accidents that they had previously reported at the time of accident. This measure of agreement represents a lower degree of reliability for interview material on the subject of an accident than that encountered on such topics as exposure and occupation. Improvements in interviewing techniques might increase the yield from this source.

It is not essential, however, to obtain information on an accident from the respondent in the interview so long as official machinery exists for this purpose. Accident reports on file in the bureau of motor vehicles can serve as the sole source for the numerator. Computing accident rates from this secondary but official source should introduce no crucial bias. The study sample, of course, should be of sufficient

size to compensate for the proportion of accidents learned at interview only.

Deserving of mention is the encouraging frankness encountered during the interviews on subject matter ordinarily considered touchy. Information was voluntarily given by most individuals on the matter of drinking, speeding, license suspension, and, in spite of the fact that the interviews were for an automobile accident study, on various physical disabilities and chronic diseases.

A few individuals interviewed did not state their age; a few did not state exposure. Thirteen men and 35 women did not state the number of miles driven. These omissions, which account for the variations in the study population from table to table and chart to chart, result from two factors: The omissions were not discovered soon enough after the interview to be rectified, and the question on exposure was apparently a difficult one for some persons to answer accurately. Interview techniques and questions especially developed to arrive at the estimate of exposure would help respondents supply an accurate figure.

We recognize that information on accident rates related to fairly well defined, stable characteristics may be rewarding for only a portion of accidents. Many accidents may be more closely related to very fleeting human attributes such as temporary emotional tensions. These, of course, present special, complex problems for study and validation.

If we had studies based on populations of suitable size, we could look for answers to such questions as: To what age group among the general population should special efforts be directed with regard to the screening and retraining of automobile drivers who have had accidents? What is the part of the physically impaired person in the accident problem? Of the deaf individual? The intoxicated driver? The habitual speeder? The slow driver?

We have shown that the epidemiological method of evaluating certain characteristics of drivers and other important aspects of the traffic problem can be expected to provide critical results expressed in convincing accident rates. As a result, the New York State Health Department has been sufficiently encouraged to plan a traffic investigation, greater in scope than the Saratoga Springs study, in collaboration with other agencies concerned with the problems of traffic safety.

Two refinements not employed in the Saratoga Springs study will be made in future attempts to define accident-involved individuals. First, accidents that are manifestly the result of the operation of a defective vehicle or of an environmental hazard will be excluded from consideration in those instances where the judgment of the driver is not involved. Second, responsibility for an accident may be fixed for a group of individuals in order to define the accident-susceptible individuals more accurately.

Summary

A method for determining motor vehicle accident rates for groups within a general population has been tested in a preliminary manner by means of home interviews of a sample in a New York State community. It is suggested that, given sufficient data, accident rates can be determined for well-defined population groups which would assist considerably in providing direction and impulse for accident prevention activities.

REFERENCES

(1) National Academy of Sciences-National Research Council, Committee on Highway Safety Research: The field of highway safety research. A brief outline. Washington, D. C., The Council, 1952.

(2) Holcomb, R. L.: Alcohol in relation to traffic accidents. J. A. M. A. 111: 1076–1085 (1938).

(3) Lucas, G. H. W., Kalon, W., McCall, J. D., Griffith, B. A., and Smith, H. W.: Quantitative studies of the relation between alcohol levels and motor vehicle accidents. *In* Proceedings of the second Highway Safety Research Correlation Conference on Health, Medical, and Drug Factors in Highway Safety, April 1954, sponsored by the Committee on Highway Safety Research. Washington, D. C., National Academy of Sciences-National Research Council, 1955.

(4) Arbous, A. G., and Kerrich, J. E.: Accident statistics and the concept of accident proneness. Biometrics 7: 340–432 (1951).

(5) National Safety Council: Accident facts—1951. Washington, D. C., The Council, 1952.

(6) Missouri State Highway Department: Expressways, Greater Kansas City. Jefferson City, Mo., The Department, 1951.

(7) National Safety Council: Accident facts—1954. Washington, D. C., The Council, 1955.