Involvement of Alcohol in Fatalities of Wisconsin Drivers

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DEATHS in motor vehicle accidents, accounting for more than 50,000 fatalities annually (*1*), have been recognized as a public health problem. The role of alcohol in these traffic accidents has not been thoroughly investigated. Some estimates (*1*, *2*) place the rate of involvement at relatively low levels (25 to 40 percent). Data from our study of Wisconsin driver fatalities show these estimates to be unrealistically low because they are based in part on data concerning all traffic accidents. More comparable data place the significant alcohol involvement at 48 to 57 percent of all drivers killed in single-car accidents (a summary of five studies, reference 3), 62 percent involvement in 37 accidents in New York City (*4*), 64 percent involvement in 72 accidents in Washtenaw County, Mich. (*5*), 50 percent involvement in all accidents reported by the National Safety Council (*6*), and 25 to 75 percent involvement in accidents discussed in a review of 13 sources including four international studies (*7*).

Several studies based on post mortem data indicate that the chronic drinker may be partly responsible for the high fatality rates. Waller (*8*) showed that 62 percent of drunk drivers had liver pathologies, while only 15 percent of sober drivers exhibited pathological effects of drinking. Subsequently, Waller and associates (*9*) and Selzer and Ehrlich (*10*), among others, identified the chronic drinker as the most significant contributor to motor vehicle fatalities involving alcohol.

Our study specifically refutes two general claims: that the "cockeyed drinker constitutes neither a pedestrian nor a driving problem. Most of these individuals are either too drunk to drive or walk and hence sleep it off" (*2*); and that "very few teenage driving accidents occur after drinking . . ." (*11*).

Moore's study of fatalities in the neighboring State of Illinois (*7*) indicates that the involvement rate (involvement of alcohol in motor vehicle fatalities) is 43 percent. Our study presents similar but more detailed data for Wisconsin.

Our objective was to assess the influence of various blood alcohol levels in drivers killed in motor vehicle accidents, in combination with other variables, on the incidence of traffic fatalities in Wisconsin. The study is based in part on data collected as a result of Wisconsin Statute 346.71(2), effective February 1, 1968, which states: "In case of death involving a motor vehicle in which the decedent was the operator of a motor vehicle or a pedestrian 16 years of age

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or older and who died within 6 hours of the time of the accident, the coroner shall require that a blood specimen of at least 10 cc. be withdrawn from the body of the decedent within 12 hours after his death. . . . The blood so drawn shall be forwarded to a laboratory approved by the State Board of Health for analysis of the alcoholic content of such blood specimen. . . . The State Board of Health shall keep a record of all such examinations to be used for statistical purposes only."

Study Population

The study population consisted of 507 drivers killed in motor vehicle accidents in Wisconsin during the period February 1, 1968, through May 30, 1969. Data from the Wisconsin Motor Vehicle Department indicated that county coroners submitted specimens for 91 percent of fatalities that occurred during the study period, excluding drivers killed in Milwaukee County. This arbitrary exclusion occurs because the statute is applicable to counties having coroners. Milwaukee County has a medical examiner system and is exempt. For purposes of our study, therefore, a county of approximately 1 million was excluded from the study in a State having a population of 4 million (*12*). The more homogeneous distribution of population obtained by excluding this single large population center emphasized the nonurban character of the study.

The required tests for blood alcohol were performed in the Wisconsin State Laboratory of Hygiene at the University of Wisconsin. (This laboratory was the only one approved for the purposes of this study, and all tests were performed under the supervision of the senior author.) The data on blood alcohol were released by the division of health for "statistical purposes" only, pursuant to the stipulation of section 346.71(2) safeguarding personal identification.

Information Sources

Information on 17 variables was collected for each driver fatality in the study population. Age, sex, and blood alcohol level and the time, date, and location of each accident were obtained from coroners' reports. These data were verified by accident reports of the Wisconsin Motor Vehicle Department. Additional information on location of the accident (whether urban or rural), type of vehicle involved, number of vehicles involved, number of persons injured, number of persons killed, and county and city of residence of the driver was obtained from traffic records of the motor vehicle department. The number of miles from the driver's home to the scene of the accident was estimated by straight-line measurement on a map of Wisconsin. After this information was obtained, all reference to a home address was destroyed to maintain the "spirit if not the letter" of the protective clause of the statute.

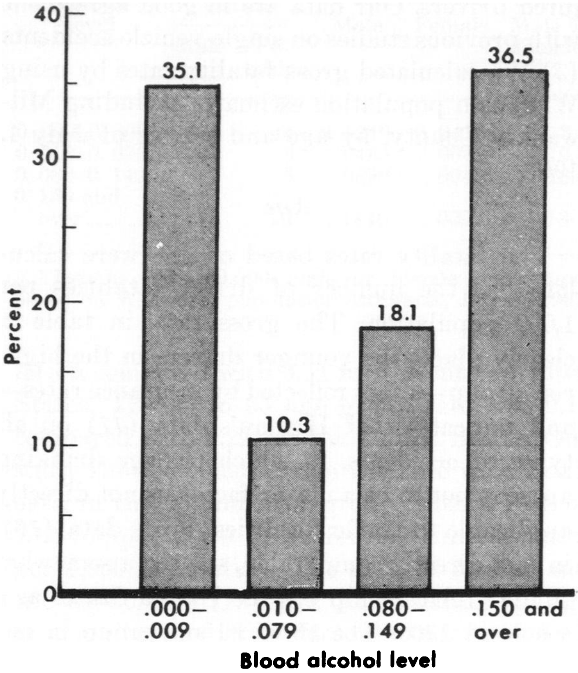
Hourly precipitation records of the university's environmental science services administration were used to determine the amount of precipitation at the time and location of the accident. Population estimates as of July 1, 1969, were used for Wisconsin counties. The distribution of Wisconsin's population by age and sex as of July 1, 1967, was obtained from the Wisconsin Department of Health and Social Services, division of health. Population distribution of Wisconsin's drivers by age and sex

Table 1. Driver's age and blood alcohol level, Wisconsin

Lower bounds of alcohol levels	Lower bounds of age groups					Total
	16	18	21	36	66	
0.000	15	33	32	69	29	178
.010	8	10	20	10	4	52
.080	8	28	36	18	2	92
.150	3	26	86	67	3	185
Total	34	97	174	164	38	507

NOTE: Chi-square=86.59 (12 degrees of freedom).

Figure 1. Percent distribution of 507 driver fatalities in Wisconsin, by blood alcohol level, February 1, 1968, through May 30, 1969



was supplied by the Wisconsin Bureau of Highway Safety, division of motor vehicles. The Wisconsin State Division of Planning supplied data on traffic volumes at the time of each accident along with daily road volumes in Wisconsin. The traffic volume data were based on hourly readings from more than 50 vehicle counters that are strategically placed on highways of the State.

Study Methods

Data on the 17 variables for each fatality were numerically coded and punched onto cards. Each card represented one fatality. With the data in this form a card sorter and a card lister could be used to make initial separations and compilations. Further, the data could be used as a "source deck" for the statistical computing program package STATJOB, available at the university's computing center. Several statistical analysis programs were available, but because of the small population and many variables in our study, the cross tabulation (CROSTAB 1) program was most applicable.

In this study CROSTAB 1 produced two-dimensional tabulations of the 17 variables. Output consisted of tables containing one variable subdivided to produce columns and one to produce rows. The number of columns (up to 11) and rows (unlimited) was controlled by the user, with no restrictions on size of intervals. Output consisted of simple variable counts and separate calculations of percent of rows, of columns, and of total tables. In addition, chi-square was calculated for each frequency table. A sample cross tabulation is presented in table 1.

Blood Alcohol Levels

For the purposes of this study, raw data on blood alcohol levels were divided into the following four groups:

SOBER—0.000–0.010—No alcohol; includes reports showing only a trace.

DRINKING—0.011–0.079—Some alcohol present in blood but definitely not under the influence.

UNDER THE INFLUENCE—0.080–0.149—Definite influence area. Some jurisdictions use the lower bound as prima facie indication; others require levels in excess of upper bound (*3, 13*).

DRUNK—0.150 and over—All jurisdictions defining drunkenness by blood alcohol levels place these levels in the "drunk" category (*3*).

While Hyman's presentation of the Grand Rapids data suggests, particularly for young drivers, that the "presumptive influence" level should start as low as 0.05 percent (*11*), we defined the category of "under the influence"

Table 2. Wisconsin driver fatality rates, by age group, February 1, 1968, through May 30, 1969

Age group (years)	Total Wisconsin population [1]	Percent of total population	Percent of total fatalities	Gross rate [2]
16–17	105, 500	5. 3	6. 7	0. 32
18–20	144, 500	7. 3	19. 1	. 67
21–35	508, 900	26. 0	34. 3	. 34
36–65	935, 000	47. 0	32. 3	. 18
66 and over	298, 700	14. 5	7. 5	. 12

[1] Wisconsin population estimates not including Milwaukee County, by age and sex, Wisconsin Department of Health and Social Services, division of health, Madison, July 1, 1967.

[2] Driver deaths per 1,000 population.

on the basis of the level of presumptive intoxication used in some areas (for example, Sweden, reference 13, and Utah, reference 3) as a lower bound (0.080). The lower bound of the "drunk" category (0.150 percent by weight) is currently used by 20 of 50 States including Wisconsin as prima facie evidence of drunkenness (*3, 14*). The 0.150 percent level and above, by weight, is direct evidence of drunkenness in all jurisdictions. As a rough guide, a 180-pound man who had consumed 7 ounces of 100-proof whiskey would in 1 hour attain the 0.150 percent level. The American Medical Association recommends 0.100 percent for the "drunk" level (*15*). Its house of delegates adopted the following policy statement: that "blood alcohol of 0.10% be accepted as prima facie evidence of alcoholic intoxication, recognizing that many individuals are under the influence in the 0.05% to 0.10% range."

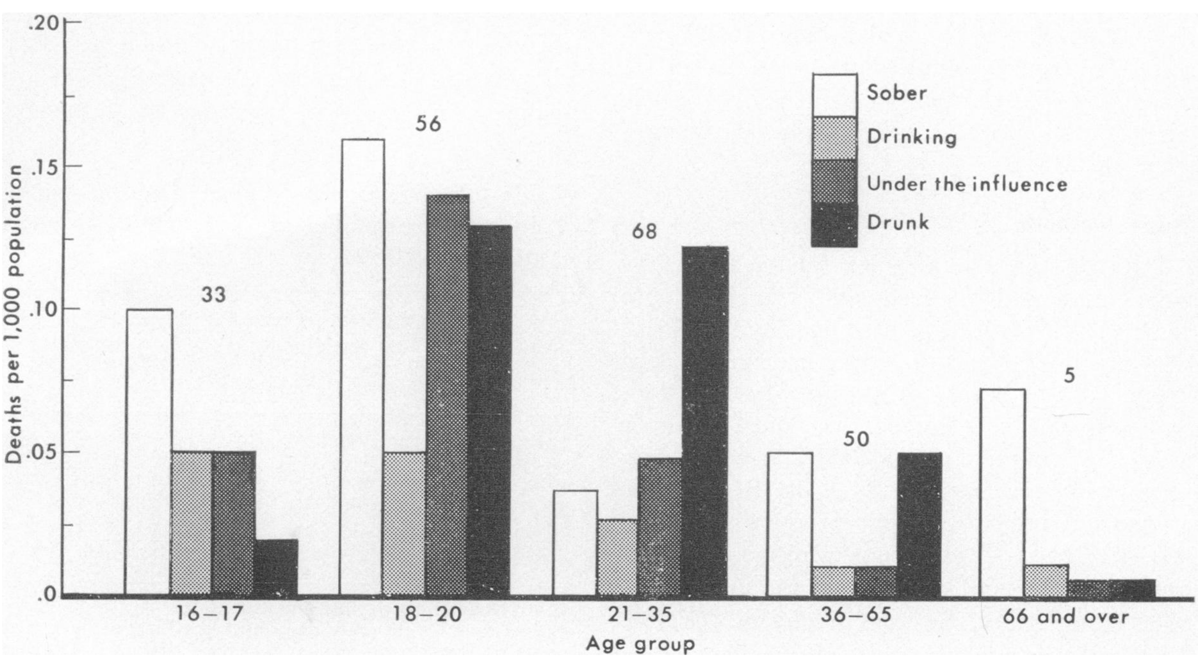
Specific Studies

The magnitude of the influence of alcohol on traffic fatalities is shown in figure 1. Approximately half of the drivers killed were either drunk or under the influence of alcohol, and half were either sober or had consumed a small amount of alcohol. Some alcohol involvement was noted in about 65 percent of all fatally injured drivers. Our data are in good agreement with previous studies on single-vehicle accidents (*3*).We calculated gross fatality rates by using Wisconsin population estimates excluding Milwaukee County, by age and sex, as of July 1, 1967.

Age

The fatality rates based on age were calculated as the number of driver fatalities per 1,000 population. The gross rate, in table 2, clearly places the younger drivers in the high-risk group—a fact reflected by insurance rates—and indicates that Hyman's data (*11*) on all types of accidents, in which teenage drinking appears not to be a major factor, is not directly applicable to traffic fatalities. Fox's data (*16*), in fact directly comparable, showed a somewhat similar relationship for the United States as a whole in 1960. The 16 to 20 age group in our study had an attack rate of 0.50 per 1,000 popu-

Figure 2. Wisconsin driver fatality rates (number of deaths per 1,000 population), by age group, February 1, 1968, through May 30, 1969



NOTE: Numbers above columns indicate percent of each group with blood alcohol levels over 0.080.

Table 3. Wisconsin driver fatality rates, by sex and blood alcohol level

Blood alcohol level	Number of deaths: Male	Number of deaths: Female	Fatality rate [1]: Male	Fatality rate [1]: Female	Ratio: Male to female
0.000–0.009	134	44	0.1240	0.0416	3.0
0.010–0.079	47	5	.0485	.0048	10.0
0.080–0.149	87	5	.0890	.0048	18.5
0.150 and over	175	10	.1810	.0097	18.6

[1] Deaths per 100,000 male or female population, based on Wisconsin population estimates, July 1, 1967.

lation compared with 0.34 for the entire United States. The 36 to 65 age group rate was 0.18 compared with 0.22 for the United States. Our study showed considerable variance with Fox's data in the 66 and over group, with a rate of 0.12 compared with 0.32 for the United States per 1,000 population. The data of McFarland and co-workers *(17)* and others listing old age as a major predictive factor in nonfatal accidents are contraindicated (for fatalities) by this study. The rationale behind the choice of age groupings was a desire to reflect (according to Wisconsin law) those persons, 16 to 17 years old, unable to legally obtain either beer or liquor; the "beer only" drivers 18, 19, and 20 years old; and the drivers 21 and over to whom hard liquor is available. The 21 to 35 age group included young adults, the 36 to 65 age group included the middle-aged, and the 66 and over group included the retired adults.

The influence of alcohol on the fatality rates in the various age groups is shown in figure 2. The bars represent the attack rates in each age-alcohol level subgroup, and the superimposed numbers indicate the percentage of each age group that has a significant alcohol level (0.080 percent and over). These data indicate that alcohol is a definite, present variable in a large percentage of all traffic fatalities. Several observations can be made:

1. Alcohol is involved in 56 percent of all driver fatalities among 16- and 17-year-olds. The 16 and 17 year group shows a percentage of drivers with an alcohol level that is significant (33 percent) by any standards but infinitely exceeds that legally permitted. This group cannot legally obtain intoxicants of any kind in Wisconsin.

2. Excluding the retired adult group, in all groups over 21 years to whom alcohol is legally available, the proportion of drivers under the influence of alcohol, with a level of 0.080 and over, is always greater than 50 percent. When the source data—all drivers killed regardless of fault in the accident—is considered, the high percentage of drivers under the influence or drunk would seem to be disproportionate to the driver population as a whole.

3. Attack rates are disproportionately high for drivers 18 to 21 years old. They increase markedly with alcohol levels in all groups but especially in the 21 to 35 age group. Similar findings have been reported for drivers involved in nonfatal accidents *(11)*.

The gross data concerning age and blood alco-

Table 4. Age-sex specific attack rates, by percent of licensed drivers in Wisconsin

Age group (years)	Women: Percent of total drivers [1]	Women: Percent of total fatalities	Women: Relative attack rate [2]	Men: Percent of total drivers [1]	Men: Percent of total fatalities	Men: Relative attack rate [2]	Both: Percent of total drivers [1]	Both: Percent of total fatalities	Ratio: Male to female
16–17	1.6	0.99	0.61	2.2	5.72	2.5	3.8	6.71	1.80
18–20	3.9	2.17	.55	5.0	16.96	3.3	8.9	19.13	2.12
21–35	14.4	2.76	.19	17.0	31.56	1.8	31.4	34.32	1.11
36–65	19.8	5.72	.29	27.2	26.63	.97	47.0	32.35	.70
66 and over	1.8	.99	.55	8.8	6.51	.74	8.6	7.50	.81

[1] Percentage based on 1968 driver population statistics compiled by Wisconsin Bureau of Highway Safety.

[2] Percent of fatalities to percent of drivers.

hol level seem to verify the hypothesis that the drinking driver is indeed a significant causative factor in traffic accident fatalities.

Sex

The relation of sex of driver and blood alcohol level to number of accident fatalities is presented in table 3. These data suffer because of the small number of fatalities among the female groups. Comparative rates within blood alcohol groupings for men and women clearly identified the male driver as the person at risk, which may reflect the sociological role of the man as a driver regardless of extent of intoxication. Vertical comparisons of the rates were misleading since the choice of breaking points by alcohol levels causes uneven groupings. The rates increased significantly for male drivers with increased levels of intoxication.

When the raw data in tables 2 and 3 were corrected for the number of licensed drivers in each age group and the relative attack rates were calculated, a clearer picture emerged (table 4). Based on the percentage of licensed drivers, the male driver's risk of an accident fatality in all categories was three or more times greater than for a female driver in the same age group. The younger drivers of both sexes were clearly the most accident prone. An interesting observation was made by correlating the data in table 4 and figure 2. The 21 to 35 age group showed the highest percentage of drivers (68 percent) with a significant level of blood alcohol, while the relative attack rate was about half that for the 18 to 20 age group. Perhaps the ability to "hold alcohol" or at least control a car while under the influence of alcohol comes with experience.

Blood Alcohol Level

Table 5 is an extension of table 4. The number of drivers in each age group (table 5) was subdivided by the blood alcohol level. Although some table cells are void, the trend of alcohol level according to age and sex involvement is clear.

Time of Accident

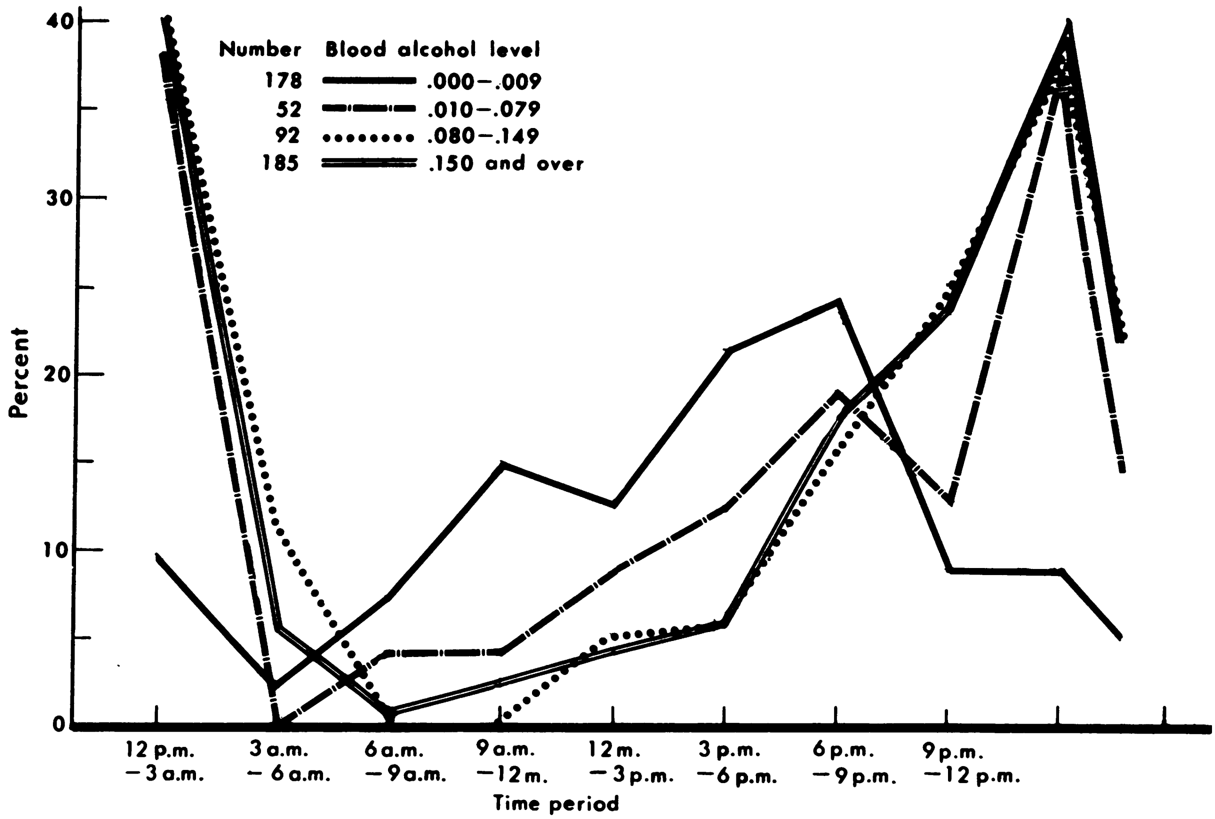
By studying the time of the accident, two questions could be investigated. First, did more fatal accidents occur during a certain time period? Second, how did the alcohol levels of the drivers involved relate to the time-frequency distribution of fatal accidents?

Two significant facts emerged from the data (fig. 3). Driver fatalities involving nondrinking drivers were distributed almost evenly over the

Table 5. Sex-specific, blood-alcohol age distributions of driver fatalities in Wisconsin

Age group (years)	Women			Men		
	Relative attack rate	Blood alcohol level	Percent of age group	Relative attack rate	Blood alcohol level	Percent of age group
16–17	0.61	0.000–0.010	60.0	2.5	0.000–0.010	34.6
		0.011–0.080	40.0		0.011–0.080	23.1
		0.081–0.149	0		0.081–0.149	30.8
		0.150 and over	0		0.150 and over	11.5
18–20	.55	0.000–0.010	81.8	3.3	0.000–0.010	26.9
		0.011–0.080	9.1		0.011–0.080	11.5
		0.081–0.149	9.1		0.081–0.149	32.1
		0.150 and over	0		0.150 and over	29.5
21–35	.19	0.000–0.010	45.5	1.8	0.000–0.010	13.7
		0.011–0.080	9.1		0.011–0.080	12.9
		0.081–0.149	9.1		0.081–0.149	20.1
		0.150 and over	36.4		0.150 and over	53.2
36–65	.29	0.000–0.010	69.2	.97	0.000–0.010	33.9
		0.011–0.080	0		0.011–0.080	8.1
		0.081–0.149	11.5		0.081–0.149	12.1
		0.150 and over	19.2		0.150 and over	46.0
66 and over	.55	0.000–0.010	80.0	.74	0.000–0.010	75.0
		0.011–0.080	20.0		0.011–0.080	9.4
		0.081–0.149	0		0.081–0.149	6.3
		0.150 and over	0		0.150 and over	9.4

Figure 3. Percent distribution of 507 driver fatalities in Wisconsin, by blood alcohol level and time period



24-hour period, with the peak traffic hours near dusk showing the highest rate. In the groups with alcohol involvement, 64 percent of all motor vehicle accidents of drunk drivers and 62 percent of accident fatalities involving drivers under the influence of alcohol occurred between 9 p.m. and 3 a.m.

Two factors bear on these data. First, from 9 p.m. to 3 a.m., traffic was at its lowest volume. Approximately 12 percent of the mean daily traffic on a given road occurred during this 6-hour period, or during one-quarter of the 24-hour day. These figures were based on an average hourly count of cars from 30 selected counters on Wisconsin highways. Second, the bars closed around 1 a.m. or 2 a.m. Zylman (*18*), analyzing data from a predominantly urban Grand Rapids study, found similar results; 47 percent of drivers involved in nonfatal accidents showed a significant blood alcohol level, greater than 0.05 percent, in the midnight to 3 a.m. interval.

Data concerning two other urban areas, Sacramento and Alameda Counties, Calif., showed similar results over a 7-year period involving 157 drivers (*3*). Nondrinking drivers in the California studies followed our nondrinking drivers' curve almost exactly, reflecting in both studies holiday traffic volumes. The time dependence of alcohol-involved crashes in both urban (*3*, *18*) and predominantly nonurban areas in our study would further tend to negate the effect of other variables and support alcohol as a primary causative factor of driver fatalities.

Type of Accident

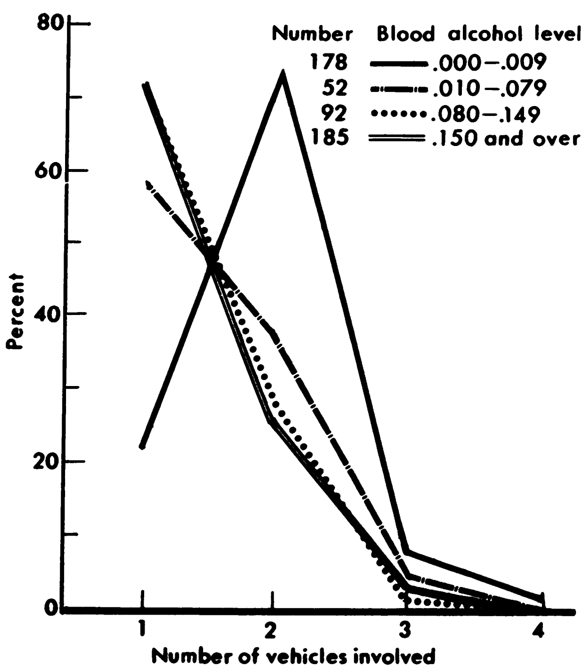
To assess the influence of the drinking driver on the total number of motor vehicle accidents, each accident involving a fatality was classified by the number of vehicles involved. Five reports (*3*) showed that 48 to 57 percent of drivers who were fatally injured in single vehicle crashes, compared with 69.1 percent in our study, had a blood alcohol level greater than 0.1 percent.

Time of day of the accident and control group studies have shown that the drunk driver comprises only 1 to 4 percent of the total population at risk but accounts for a high percentage of accidents.

In our study we reassessed these percentages for nonurban driver populations. By grouping the data primarily according to blood alcohol level and then by type of accident, the effect of alcohol on the type of accident could be examined. The number of motor vehicles involved in driver fatalities and the blood alcohol level groupings are shown in figure 4. The nondrinking driver fatalities occurred primarily in two-car accidents, whereas drinking driver fatalities occurred mostly in one-car accidents. More than 70 percent of drivers who were drunk or under the influence of alcohol were killed in one-car accidents, while 70 percent of sober drivers were killed in two-car accidents.

The drinking driver apparently is less able to control his car (that is, causes a one-car accident), while the sober driver can trace his accident partly to driver errors other than his own. This hypothesis is partly supported by two studies in which drunk drivers were found to be at fault in 44 percent of multiple vehicle crashes (*19*), and the drunk drivers caused four times as many crashes (*20*), as opposed to being crashed into. While the drinking driver appears to be the greatest hazard to himself, the mere presence of alcohol indicates that the risk of a fatal accident is nearly tripled under conditions where the driver alone is solely responsible.

Figure 4. Percent distribution of 505 driver fatalities in Wisconsin, by blood alcohol level and number of vehicles involved



NOTE: Data undetermined for two accidents.

At least three studies have shown that passengers killed in single vehicle crashes routinely have high levels of blood alcohol. A report by the U.S. Department of Transportation (*3*) indicated that passengers may in fact have substantially lower alcohol levels than drivers, though it noted that the presumption has not been fully studied. In a study involving a limited number of one-car accidents (*18*) data were available concerning the blood alcohol levels of both drivers and passengers who were killed. In 16 of 18 accidents the level of blood alcohol in passengers was lower than that in the drivers. Mean blood alcohol level for the drivers was 0.161 percent and for the passengers, 0.112 percent. The data shown in figure 5 may reflect a lack of sound judgment by the driver because of the alcohol factor.

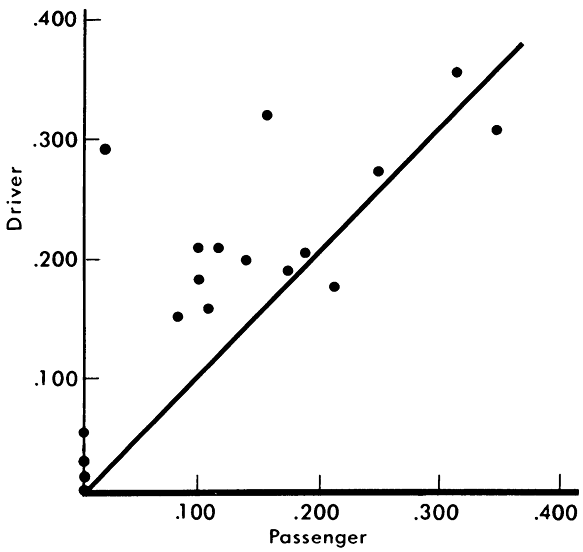
Distance of Accident From Home

To determine whether a relationship exists between distance of accident from home and blood alcohol level, the distance between the accident scene and the driver's home was gauged by straight-line measurement. Out-of-State residents were excluded; therefore, the study group included 458 drivers who were killed. When the data were plotted on alcohol percentage and distance distributions, the curves for the different blood alcohol groups were essentially the same. It was concluded that while most accidents occurred close to the driver's home, blood alcohol levels were unrelated to the variable distance from home.

Weekday-Weekend Fatality Rates

Maxwell (*21*) has confirmed and quantitated the long-held assumption that the heaviest drinking occurs over weekends and holidays. Little information is available by weekends and holidays on the involvement of alcohol in fatalities, except that the greatest number of alcohol-

Figure 5. Blood alcohol levels of drivers and passengers killed in 18 traffic accidents in Wisconsin



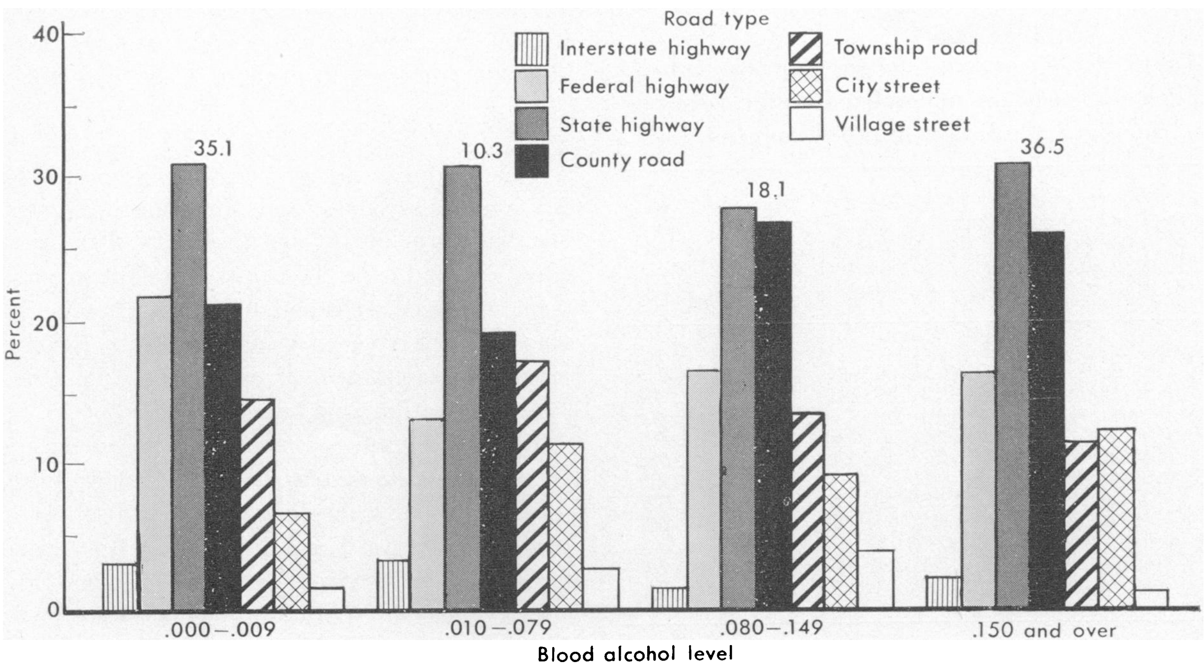
involved fatalities occur on Saturday, whereas nonalcohol-involved fatalities occur almost evenly during the week.

To relate blood alcohol level and type of day, weekday and weekend fatality rates (accidents per day) were calculated at each blood alcohol level. The study included 486 days: 347 weekdays and 139 Saturdays and Sundays. Weekend day rates were twice as high as weekday rates, but the data were essentially the same for blood alcohol levels. The effect of volume of traffic is being considered in a separate study.

Holiday-Nonholiday Fatality Rates

In a similar type of study, the effect of holidays on attack rates was investigated. Holidays included New Year's, Memorial Day, Fourth of July, Easter, Labor Day, and Christmas in 1968 and Easter in 1969. The holiday periods included the day before and the day after the calendar date. If the holiday occurred on Friday or Monday, the weekend was included. The holiday periods totaled 25 days, and the nonholiday periods, 461 days. Within each blood alcohol grouping, holiday and nonholiday fatality attack rates were calculated and holiday-nonholiday ratios were determined. In all groups the holiday rates were nearly twice the nonholiday rates. The ratio of holiday to nonholiday rates tended to increase slightly with blood alcohol levels.

Figure 6. Percent distribution of 458 driver fatalities in Wisconsin, by blood alcohol level and type of road



NOTE: Numbers above columns indicate percent of each group with blood alcohol levels over 0.080.

Types of Roads

Our study included seven types of roads and highways in Wisconsin: interstate, Federal, State, county, township, city street, and village street. Data in figure 6 include subdivisions by type of road and by blood alcohol group. The superimposed numbers on the chart indicate the percentages of total fatalities involving blood alcohol levels over 0.080. The general form of the data indicated that the distribution of drivers killed, by road type, was essentially the same for all blood alcohol levels. The data were limited by the small number of fatalities in some categories. Raw data indicated that the greatest number of fatalities occurred on State highways. The question resolves into accident rates based on traffic volume and the influence of the drinking driver on these rates.

Traffic Volumes

Traffic volume, or number of cars per hour, on a given road at the time of each accident was estimated from data from the State division of planning. Hourly traffic counts were available from more than 50 strategically placed permanent counters throughout Wisconsin. Usually, it was possible to determine the hourly traffic volume at the time of the accident from a counter close to the accident location. Alternately, the count was obtained from the nearest counter on a similar highway. We included only the 444 fatalities in rural areas in this portion of the study since accurate hourly traffic volumes for the urban areas were not available.

To learn whether a relationship existed between the number of cars on the road and the level of blood alcohol among the drivers, the data were handled as follows. All fatalities were divided according to blood alcohol levels, as before. Actual car counts or number of cars per hour were obtained for each accident from the nearest road counter at the time of the accident. Car counts were grouped to provide traffic density intervals; that is, one to five or six to 25 cars per hour. Considering the number of fatalities in each blood alcohol group as a population, we calculated the fraction of accidents in each density interval. We divided this fraction by the average number of cars per hour during the interval—an average of 3.15 cars per hour was on the road when accidents occurred during the interval of one to five cars per hour—and computed the attack rate based on actual traffic density.

Most accidents occurred in relatively low traffic densities, which perhaps indicates that drivers are lulled into a false sense of security by the absence of traffic. For drivers with blood alcohol involvement, the attack rate rose rapidly with increasing levels of blood alcohol.

Table 6. Wisconsin driver fatality attack rates, based on normalized traffic volumes during 25 holidays and 461 nonholidays

Type of highway and day	Fatalities	Mean daily traffic volume (cars)	Normalized daily traffic volume [1]	Relative attack rate [2]
Interstate:				
Holiday	2	50, 965	8. 36	0. 0096
Nonholiday	12	43, 772	8. 19	. 0032
Federal:				
Holiday	14	12, 150	1. 99	. 281
Nonholiday	77	10, 926	2. 04	. 082
State:				
Holiday	13	6, 092	1. 00	. 520
Nonholiday	141	5, 344	1. 00	. 306
County:				
Holiday	11	2, 045	. 34	1. 29
Nonholiday	109	1, 986	. 37	. 64

[1] Normalized to State highway volumes; see text.
[2] Attack rate=number of fatalities per day divided by normalized traffic volume.

Multiple Variant Analysis

This analysis included traffic volumes, holiday-nonholiday data, and blood alcohol levels. We had previously considered fatality rates based on road type. To compensate for unequal traffic volumes, we calculated a mean traffic volume for each type of road. Raw data for this calculation consisted of car counts, identified by date, location, and type of highway.

Typical counter locations were selected: five on the interstate system, three on Federal highways, three on State highways, and three on county highways. The holidays have been specified. Holiday data included 3 to 5 days of the holiday period. Nonholiday counts were made from the same counters on the same days of the week 1 week later. The total counts at each

Table 7. Relative driver fatality attack rates, by type of road and day and blood alcohol level, Wisconsin

Type of road and day	Blood alcohol level: 0.000–0.010, percent by weight	0.011–0.079, percent by weight	0.080–0.149, percent by weight	0.150 and over, percent by weight
Interstate:				
Holiday	0.005	0.000	0.000	0.005
Nonholiday	.001	.0005	.0002	.0007
Federal:				
Holiday	.08	.04	.04	.12
Nonholiday	.04	.005	.015	.024
State:				
Holiday	.24	.00	.16	.12
Nonholiday	.11	.03	.05	.12
County:				
Holiday	.47	.00	.12	.71
Nonholiday	.19	.05	.14	.24

NOTE: Data were corrected for relative traffic volumes. See table 6.

counter were averaged for a daily volume for each holiday and each nonholiday period, and the daily rates were grouped by road type to obtain mean holiday and nonholiday volumes. The daily traffic volume was computed for each type of highway and "normalized" to State highway volumes (table 6). For example, an interstate highway through Wisconsin at any given time might carry approximately eight times the volume carried over the State highways at the same time.

To assess the effect of blood alcohol level on holiday and nonholiday attack rates, we conducted the following study. For each type of road, on holidays and nonholidays, the number of fatalities was determined at each blood alcohol level. The number of fatalities within any alcohol group for a given road type divided by the relative traffic volume yields an attack rate specific to road type, alcohol level, and holiday-nonholiday periods, as summarized in table 7.

Several interesting observations emerged. We found that in any alcohol group the interstate highway system, despite high routine and holiday volumes, was considerably safer than all other types of highways in actual risk per car. In almost all blood alcohol groups, the holiday periods were characterized by higher risk than that for corresponding nonholiday periods. On the basis of table 7, the under-the-influence and drunk driver had the highest risk compared with sober drivers on the same type of highway and the same type of day. Although not strictly applicable to the nonurban population in our study, other studies have placed the incidence of drivers with blood alcohol levels greater than 0.1 percent at 1 to 4 percent of all U.S. drivers (*3*), greater than 0.05 percent alcohol at 8.7 percent in Toronto, Canada (*22*), and greater than 0.02 percent alcohol at 16 percent in New York City (*23*). Since drunk drivers constitute a very small percentage of total drivers on the road, the actual attack rate (that is, deaths per 1,000 drunk drivers) of table 7 is grossly low for the higher blood alcohol groups.

Although this study suffers because the quantity of data is small, the data for drunk drivers and drivers under the influence of alcohol indicate that the greatest danger of accidents is on the less traveled county roads, typically two-lane surfaced roads designed for lower speeds. These data may reflect the tendency of the drunk driver to avoid more heavily traveled and patroled roads.

Table 8. Wisconsin driver fatality rates, by counties

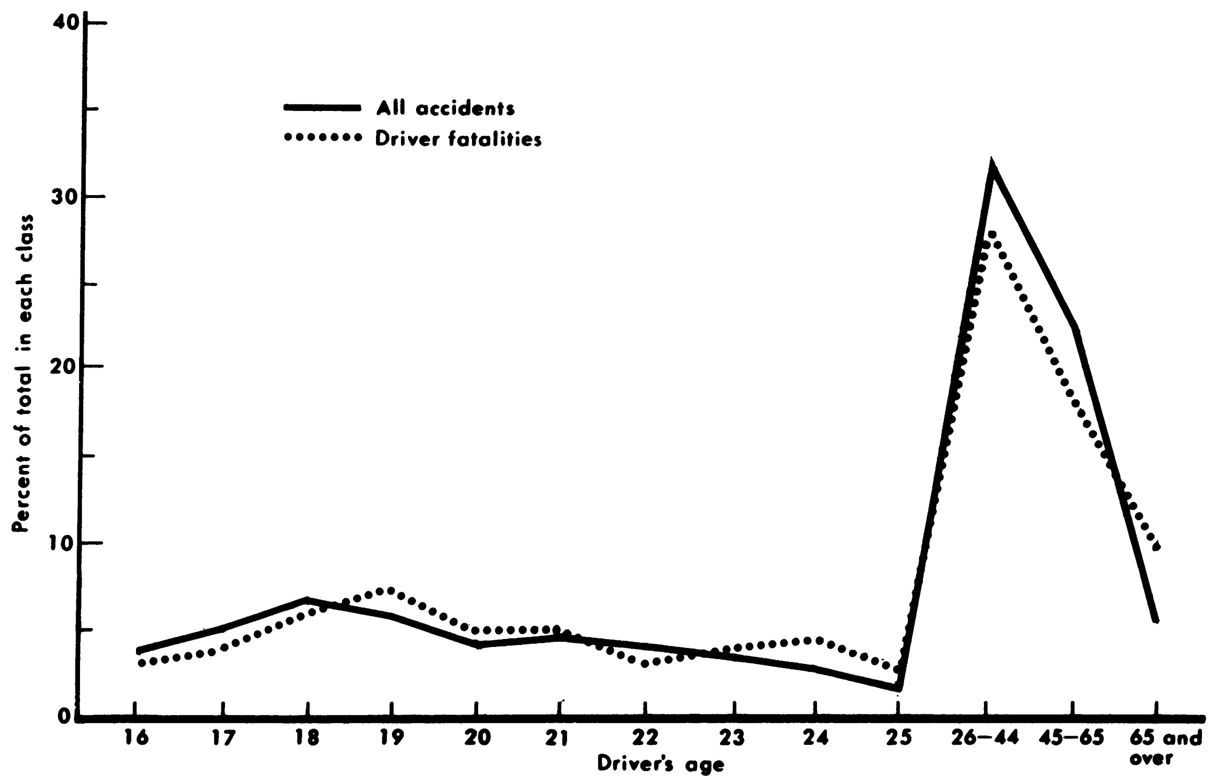
County, by rank [1]	Density (population per square mile)	Number of fatalities	Fatalities per 1,000 population
1 Racine	496.1	17	.10
2 Waukesha	405.6	38	.17
3 Kenosha	394.0	20	.19
4 Brown	278.3	23	.16
5 Winnebago	271.9	8	.06
6 Dane	236.8	23	.08
7 Ozaukee	207.2	7	.14
8 Sheboygan	180.3	13	.14
9 Rock	179.9	21	.16
10 Outagamie	178.9	17	.15
11 La Crosse	160.6	16	.37
12 Washington	137.6	11	.19
13 Manitowoc	132.3	10	.13
14 Fond du Lac	107.5	13	.17
15 Walworth	100.0	12	.21
16–71 [2]	100→6.0	258	----------

[1] Counties with approximate densities of 100 or more persons per square mile; Milwaukee County excluded.
[2] Combined total for 55 counties.

Table 9. Group driver fatality attack rates, based on county population densities, Wisconsin

Number of counties in group	Density range (persons per square mile)	Total population in group X 10⁻³	Number of fatal accidents in group	Group rate per 1,000 population	Blood alcohol level, percent	Number of fatalities per group	Group rate per 1,000 population
33	6.0– 29.1	491	77	0.16	0.000–0.009	34	0.07
					0.010–0.079	9	.02
					0.080–0.149	14	.03
					0.150 and over	20	.04
12	31.3– 43.8	383	52	.14	0.000–0.009	17	.04
					0.010–0.079	6	.01
					0.080–0.149	6	.01
					0.150 and over	23	.06
9	45.1– 82.2	395	58	.15	0.000–0.009	24	.06
					0.010–0.079	2	.01
					0.080–0.149	9	.02
					0.150 and over	23	.06
8	94.7–178.9	574	91	.16	0.000–0.009	29	.05
					0.010–0.079	10	.02
					0.080–0.149	11	.02
					0.150 and over	41	.07
7	179.9–394.0	930	105	.11	0.000–0.009	30	.03
					0.010 0.079	12	.01
					0.080–0.149	29	.03
					0.150 and over	34	.04
2	405.6–496.1	393	55	.12	0.000–0.009	12	.03
					0.110–0.079	8	.02
					0.080–0.149	10	.02
					0.150 and over	18	.04

Figure 7. Percent distribution of all accidents and driver fatalities in Wisconsin, by driver's age, February 1, 1968, through May 30, 1969



Population Densities

Wisconsin county population densities, as of July 1, 1969, ranged from 496.1 to 6.0 persons per square mile (table 8). The mean attack rate for all counties in the study was 0.20 driver fatalities per 1,000 population.

To ascertain the effect of population density on attack rates, the counties were grouped by population density, and the total population in each group of counties was used to calculate the rates (table 9). Corrected rates indicated no relationship between blood alcohol levels and attack rates, but showed that the low-density counties had slightly higher attack rates, based on total population in Wisconsin.

Amount of Precipitation

The amount of precipitation during the hour of the accident proved to be unrelated to blood alcohol levels. Most fatalities (447) occurred during minimum or no precipitation (zero to 0.03 inch). Too few fatalities occurred during the other precipitation ranges to warrant study.

"Dry" Counties

Milwaukee County, with a population of 1.3 million, has a uniform "no teen bar" ordinance, which gives rise to a recurrent question in Wisconsin concerning the incidence of traffic accidents. Large numbers of 18- to 20-year-olds drive outside the county to "beer islands" in surrounding counties. Presumably, these trips would lead to a higher incidence of accidents in the 18 to 20 age group in surrounding counties, but data concerning Milwaukee County residents killed in immediately adjoining counties (table 10) show that this may not be true.

Of 26 driver fatalities, only two were under the age of 21, and only one had been drinking. Two explanations are possible: (*a*) either the drivers under 21 were not killed until they reentered Milwaukee County and our study did not record their deaths or (*b*) the popular beer-island idea concerning traffic accidents is invalid. A more extensive study of traffic accidents in Milwaukee County is required for clear definition.

Discussion

This study was limited to drivers who were killed in motor vehicle accidents in Wisconsin. The relationship of the drinking driver to total accidents was not explicitly defined. Statistical information from the Wisconsin Bureau of Highway Safety, division of motor vehicles, provided an age-percent distribution of total accidents of all types and an age-percent distribution of fatal accidents. For example, 22-year-old drivers were involved in 3.6 percent of all types of accidents and 3.4 percent of all fatal accidents. The data for total accident fatalities and accidents without fatalities in Wisconsin are plotted in figure 7. From these data one might presume that accident fatalities represent a fixed percentage of all accidents in each age group. If the data on the relative influence of alcohol were logically extended to all accidents, the problem of the drinking driver would reach epidemic proportions.

Conclusions

More than half of the drivers killed in traffic accidents on Wisconsin highways from February 1, 1968, through May 30, 1969, were either drunk or significantly under the influence of alcohol at the time of the accident. The 18 to 20

Table 10. Driver fatalities of Milwaukee County (Wis.) residents occurring in adjacent counties, February 1, 1968, through May 30, 1969

Blood alcohol level	Age group (years)					
	16–17	18–20	21–35	36–65	66 and over	Total
0. 000–0. 010	1	--------	2	2	3	8
0. 011–0. 079		1	2	1	--------	4
0. 080–0. 149			2	1	--------	3
0. 150 and over			2	9	--------	11
Total	1	1	8	13	3	26

age group had the highest fatality rate. Female drivers had a much lower driver fatality attack rate than male drivers.

Nondrinking driver fatalities were almost evenly distributed throughout the day, whereas the highest percentages of drinking driver fatalities occurred from 12 p.m. to 3 a.m. The single-car accident was characteristic of fatal accidents involving the drinking driver, whereas most sober driver fatalities were the result of two-car accidents. No relationship was found between distance from home and blood alcohol level of the driver.

Differences between weekend and weekday fatality rates were independent of blood alcohol level. At all blood alcohol levels, the weekend day rate was approximately twice the weekday rate. Weekend traffic volumes per day, however, were not twice the weekday volumes, which indicates that factors other than drinking, such as fatigue, speed, and so forth, may be causative. Holiday fatality rates were at least double the non-holiday rates. Data corrected for traffic volumes still exhibited this trend. At low levels of traffic, one to 25 cars per hour, the attack rate increased with increased blood alcohol levels.

Interstate highways had the lowest fatal accident attack rates, and county highways had the highest rates, based on actual traffic volumes. Apparently no correlation existed between attack rates and the population density of the county in which the accident occurred. A study of fatalities among drivers under 21 years of age in counties adjoining Milwaukee County did not support the "beer island" assumption.

Summary

A Wisconsin study of 507 drivers killed in motor vehicle accidents in the State during the period February 1, 1968, through May 30, 1969, disclosed that more than half of the drivers were either drunk or significantly under the influence of alcohol at the time of the accident. Young people, 16 to 20 years old, had a fatality rate of 0.50 per 1,000 population compared with 0.22 for the entire United States. Women had a much lower fatality rate than men; that for men classified as "drunk" was 0.1810, and that for women in the same category was 0.0097.

The highest percentage of drinking driver fatalities occurred from 12 midnight to 3 a.m. Nondrinking driver fatalities were almost evenly distributed throughout the day. Most fatalities of sober drivers were the result of two-car accidents; the drinking driver usually was killed in a single-car crash.

At all blood alcohol levels, the weekend day rate was approximately twice the weekday rate. Weekend traffic volumes per day, however, were not twice the weekday volumes, which indicates that factors other than drinking, such as fatigue and speed, were causative. Saturday was the day most frequently named for alcohol-involved fatalities; most nonalcohol-involved fatalities occurred almost evenly during the week. Holiday rates on all types of roads were at least double the nonholiday rates. Fatality rates on county roads, which held the greatest danger for drinking drivers, were 0.71 for holidays and 0.24 for nonholidays. Interstate highways were the least hazardous, based on actual traffic volumes; comparative fatality attack rates for drunk drivers over holidays was 0.005 and over nonholidays, 0.0007.

Data corrected for traffic volumes also showed the same trends. At low levels of traffic (one to 25 cars per hour) the fatality rate increased with increased blood alcohol levels.

Milwaukee County, which was excluded from this study, has a uniform "no teen bar" ordinance, and large numbers of 18- to 20-year-olds drive from that county to "beer islands" in adjoining counties that were included in the study. These trips presumably would lead to a higher incidence of accidents among this age group, but the study data show that this presumption may not be true. Of 26 driver fatalities, only two were under the age of 21, and only one had been drinking. Two explanations are possible: Either the drivers under 21 were not killed until they reentered Milwaukee County and the study did not record their deaths, or the popular idea concerning "beer island" traffic accidents is not valid.

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Tearsheet Requests

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