UM-HSRI-81-24

ALCOHOL-RELATED ACCIDENTS AND DUIL ARRESTS IN MICHIGAN: 1978-1979

L.D. Filkins
J.D. Flora

APRIL 1981

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UM-HSRI-81-24		

4. Title and Subtitle	5. Report Date
Alcohol-related Accidents and DUIL Arrests in Michigan: 1978-1979	April 1981
	6. Performing Organization Code
	8. Performing Organization Report No.
7. Author(s)	UM-HSRI-81-24
L. D. Filkins and J. D. Flora	
9. Performing Organization Name and Address	10. Work Unit No.
Highway Safety Research Institute The University of Michigan Ann Arbor, Michigan 48109	11. Contract or Grant No. MAL-79-002B
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	Interim 3/80 - 4/81
Office of Highway Safety Planning Michigan Department of State Police Lansing, Michigan 48913	14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract

Twelve years of Michigan accident data, 1968-1979, were analyzed to assess the impact of lowering the minimum legal drinking age from 21 to 18 on January 1, 1972, and subsequently raising it back to age 21 on December 23, 1978. Driver age and the presence or absence of drinking in the accident were the key variables, and partitioning the chi-square statistic into its degrees of freedom was the primary analytic technique. DUIL arrest data were also obtained and analyzed for 1978 and 1979.

The results show clearly that the minimum legal drinking age influences drinking-driving patterns among the affected age groups. Alcohol-related accidents increased among 18- to 20-year-old drivers when the legal drinking age was reduced to 18, and non-fatal accidents decreased when it was later increased to 21. The DUIL arrest data strongly indicate that all age groups except 18-20 increased in DUIL arrests from 1978 to 1979, while the 18-20 age group concurrently experienced a decrease.

DUIL enforcement indexes--the ratio of DUIL arrests to alcohol-related accidents--were calculated for 1978 and 1979. An index was calculated for the entire state, for each of the 83 counties, and for the 56 Michigan cities having a population of at least 20,000.

17. Key Words	18. Distribution Statement
	Unlimited

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	88	

ACKNOWLEDGEMENTS

The continuing cooperation of the Michigan Department of State Police in providing accident data for inclusion in HSRI's Automated Data Access and Analysis (ADAAS) System is gratefully acknowledged. Thanks are due also to HSRI's Data Operations Group for its operation and maintenance of ADAAS, which contributed greatly to the efficient handling of the the accident data in this project.

Breathalyzer test report data were obtained through the courtesy of the Michigan Departments of State and State Police. The coding staff, supervised by M. Compton, consisted of G. Bray, S. Green, L. Nicholas, and P. Pasterz. Data entry of all breath-test reports into computer files was performed by P. Ferullo.

The authors gratefully acknowledge the contributions of all these individuals and organizations.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

All accidents occurring in Michigan that were investigated by police agencies and reported on official forms were obtained for the twelve years from 1968 through 1979. Two subsets of these data were formed, one a 20% sample of all accidents irrespective of accident severity, and the other a census of all fatal accidents. Driver involvements in these accidents, and involvements in alcohol-related accidents, were analyzed by age and by year of occurrence.

Arrest data for DUIL (Driving Under the Influence of Liquor) offenses were also obtained for 1978 and 1979. UD-31 breath test report forms were used for those cases in which the DUIL defendant provided a valid breath test, and these forms provided the date, place, and time of arrest, the age of the driver, and the driver's blood alcohol content. Aggregate data, providing only broad age groupings of the involved drivers, were also obtained for 1978 and 1979 for DUIL defendants who refused to take a breath test for determination of blood alcohol content.

The accident and DUIL datasets were analyzed both separately and jointly for several purposes. Analysis of the accident data focused on driver involvements in alcohol-related accidents as determined by the HBD (Had Been Drinking) variable recorded on the police accident report form. The specific topics of concern were the changes that occurred among the affected age groups because of the lowered legal drinking age in 1972 and the increased legal drinking age in 1979. The DUIL arrest data were also used to examine the effects on drinking-driving patterns of the increased legal drinking age. Additionally, the effect of the warrantless arrest law (effective August, 1978) was analyzed using the DUIL dataset. Elements of the two data sets were also

combined to generate a DUIL enforcement index--the ratio of DUIL arrests to alcohol-related accidents--for the state as a whole, for each of the 83 counties, and for the 56 cities having population of 20,000 or greater.

Determination of the effects on traffic safety of the two changes that occurred in the legal drinking age requires careful analysis and attention to other changes which might alter reported alcohol-related accidents. During the past twelve years three changes have occurred in reporting practices. From 1968 through 1971 there was a gradual growth in the completeness of the digital files for non-fatal accidents, from about 55% complete in 1968 to 100% complete in 1972 and subsequent years; fatal accidents, however, were complete from 1968 (and earlier) on. In 1971, the way in which alcohol involvement is recorded on the accident-report form was changed. In 1974 FARS (Fatal Accident Reporting System) was introduced, and this reduced the missing data on the HBD variable, with the result that an artifactual increase in the frequencies of alcohol-related accidents occurred. These early changes in reporting practices largely were accounted for by the analytical techniques employed, and the changes do not affect the data in the later years. In addition, there have been changes in the larger context which influence drinking patterns and driving patterns, both singly and in combination. One can cite the energy crisis of the mid-1970's and the recent economic downturn. These perturbations, of course, preclude simple before-after comparisons of only the affected age groups in the analytical and inferential work, but they cannot in any sense be used to dismiss the findings out of hand.

The combined results of the analytical work on the accident and DUIL datasets clearly and unequivocally demonstrate that the legal drinking age influences drinking-driving patterns among younger drivers. Drivers aged 18-20 in the 20% sample accident data had statistically significant increases in

their involvement in alcohol-related accidents when the legal drinking age was reduced, and significant reductions when the legal drinking age was increased. In fatal accidents, these drivers had significant increases--in both HBD rates and frequencies--when the drinking age was reduced. The subsequent reduction in HBD rate found in the 20% sample data (when the age was increased) was not duplicated in the fatal data. However, a reduction in the frequencies of HBD involvements among the 18- to 20-year-old drivers did occur; the 5-year average (1974-1978) of 179 HBD involvements in fatal accidents decreased to 160 in 1979, a 10.5% reduction. This reduction occurred at the same time that all other drivers experienced a 12.1% increase in their fatal HBD involvements, from an average of 679 in the 1974-1978 period to 761 in 1979.

HBD rates for several cohorts of drivers were also analyzed. (The cohorts of interest here, for example, are those drivers who were age 16 in 1976, age 17 in 1977, etc.) Without exception, the HBD rates for every cohort that could be analyzed increased sharply in the year in which the cohort was legally enfranchised to drink. This occurred whether the legal drinking age at the time of enfranchisement was 18 or 21. Further, the increases at the year the cohort could drink legally occurred in both the fatal dataset and in the 20% sample dataset.

Analysis of the DUIL arrest data also demonstrates clearly that the recently increased legal drinking age altered drinking-driving practices among the affected drivers. The 18-, 19-, and 20-year-old drivers, whether considered singly or as a group, consistently showed fewer arrests in 1979 than in 1978. Drivers of all other ages, specifically including those just slightly younger and older, experienced more arrests in 1979 than in 1978.

Analysis of the accident data revealed wide differences in HBD rates throughout the state. The proportion of alcohol-related accidents among the counties varies by more than 3:1, with 44% in Keweenaw County (the highest), to 12% in Kent and Ottawa Counties (the lowest). The DUIL enforcement index shows even wider variations, varying from 1.07 in Gladwin County to 0.06 in Benzie County, an 18:1 ratio. The widespread differences in both the proportion of HBD accidents and in the DUIL enforcement index need to be studied to understand why such differences exist and to determine what countermeasure implications hold.

1. INTRODUCTION

This is the second interim report of a continuing project sponsored by Michigan's Office of Highway Safety Planning entitled "Drinking Driver Analysis" (OHSP Project Number MAL-79-002B). Results of the work conducted from April 1, 1979 - April 30, 1981 are presented.

The first interim report [1] dealt exclusively with analysis of nine years (1968-1976) of Michigan's fatal accident experience.[1] This report extends the work in several important respects. First, accidents for 1977-1979 have been added to the accident database, so that twelve years of accident experience are now available for analysis. Second, non-fatal accidents, in addition to fatal accidents, have been analyzed. A 20% random sample of all Michigan accidents was used for this purpose. Third, DUIL (Driving Under the Influence of Liquor) arrest data were obtained for 1978 and 1979, and the results of analyzing these data are presented. Finally, exploratory research was undertaken in connection with the conception and formulation of a DUIL enforcement index, intended to assist policy makers and program planners in the efficient allocation of limited enforcement resources.

The general impetus for the present work remains the same as for much of the prior research: alcohol continues to be the factor most frequently cited as causing traffic accidents, and the strength of the association becomes stronger as accident severity increases. Increased knowledge about the phenomenon, and about arrest activity to deal with it, should eventually lead to more effective countermeasures. The specific focus of the present work, and certainly a valid reason in itself for undertaking this study, is understanding the influence of the minimum legal drinking age on traffic safety.

---

[1] Numbers in brackets [ ] refer to References at end of report.

The effect of the legal drinking age on traffic safety has been a topic of much concern and discussion for the last decade, both in Michigan and elsewhere. In Michigan, the discussion has arisen primarily in the context of changes--and proposed changes--in the legal drinking age during the past few years. Before presenting the analysis of the accident data (Section 2) and the DUIL arrest data (Section 3), a review of changes in the legal drinking age during the last decade is in order.

1.1 Changes in Michigan's Legal Drinking Age

Michigan's legal drinking age for all alcoholic beverages had been 21 since 1937 until it was reduced to 18, effective January 1, 1972. This reduction was consistent with a nationwide revision of the age of majority from 21 to 18 and with the Twenty-Sixth Amendment to the U.S. Constitution (approved July 5, 1971) establishing the voting age in all federal elections at 18. Michigan was one of some two dozen states that reduced its legal drinking age from 21 to 18 along with the age of majority package.[1]

The legal drinking age remained at 18 until 1978 when, by legislative action, it was increased to age 19 effective December 3, 1978.[2] This action was shortly superseded, however, by an amendment to the Michigan constitution. By popular initiative a proposition was placed on the ballot to amend the constitution to make age 21 the new legal drinking age. This proposition was approved by the electorate at the November 7, 1978 general election and became effective December 23, 1978.[3]

---

[1] Act No. 79, Public Acts of 1971.

[2] Act No. 94, Public Acts of 1978.

[3] Of 5,230,345 registered voters in November, 1978, 2,818,086 (53.9%) cast valid votes on Proposition D. "Yes" votes, favoring the raised legal drinking age of 21, numbered 1,609,589, 57.1% of the votes cast. Source: Elections Division, Michigan Department of State.

Two other legal actions should be included in this brief review. In two different court cases (subsequently heard together), a group of individuals within the affected age group, their parents, and liquor licensees, challenged the constitutionality of the 1978 amendment. The cases were heard in the U.S. District Court, Eastern District of Michigan, Southern Division. The Honorable Ralph B. Guy, Jr., in his opinion dated December 22, 1978, concluded that the plaintiffs "... failed to carry their burden of proof ..." of unconstitutionality and therefore denied the request for injunctive relief to prohibit the amendment from taking effect.

Recently another attempt was made to amend the Michigan Constitution, this time lowering the legal drinking age from 21 to 19. The issue was placed before the electorate at the November 4, 1980 general election, in this instance by legislative action.[1] The voters again preferred the higher age of 21, with 61.6% favoring the higher age.[2]

1.2 Prior Research

The effect of the earlier decrease in Michigan's legal drinking age--from 21 to 18, effective January 1, 1972--has been particularly well analyzed and reported [2-5]. The research, which we consider to be thorough and in accord with modern design and analysis techniques, has produced consistent findings: the 1972 decrease in the legal drinking age from 21 to 18 resulted in an increase in alcohol-related accidents among the affected age group. Wagenaar and Douglass [6] and Wagenaar [7-9] have reported statistically significant

---

[1] ENROLLED HOUSE JOINT RESOLUTION S, State of Michigan, 80th Legislature, Regular Session of 1980, Filed with the Secretary of State July 16, 1980.

[2] Registered voters in October, 1980 numbered 5,725,713. "Yes" plus "No" votes totalled 3,654,808, 63.8% of the eligible voters. "No" votes on this Proposition B, that is those favoring retention of the 21-year-old legal drinking age, totalled 2,250,873, 61.6% of the votes cast. Source: Elections Division, Michigan Department of State.

reductions among 18- to 20-year-old drivers in non-fatal, alcohol-related accidents following the December, 1978 increase in the legal drinking age. The analysis in Section 2 supports these findings.

Nonetheless, there seems to exist considerable skepticism among public officials whether the legal drinking age influences drinking and driving behavior among younger drivers. Some of this may arise because the relevant research has not been circulated adequately or presented in the proper forums. Some of the apparent skepticism may merely reflect the fact that the findings are contrary to previously established and strongly held positions. There is also criticism--which we share only in part--of the use of the Had Been Drinking variable on accident reports and the research findings that can be inferred from it.

The latter criticism is not, of course, relevant to the analysis of DUIL arrests presented in Section 3. A DUIL arrest, which then generally leads to a breath test, is initiated by an officer at an accident or by observing an unsafe or illegal driving behavior. Consistently high blood alcohol concentrations usually are found. The average BAC of arrested and tested drivers in this dataset is above 0.17% W/V, and only 3.5% of these drivers are under the legally impaired limit of 0.08% W/V. These results strongly indicate that police officers are not making ill-advised or capricious arrests. DUIL arrests, therefore, provide an alternative measure of drunken driving to the HBD variable utilized in analyses of accidents in other studies.

2. FATAL AND 20% SAMPLE ACCIDENT DATA: 1968-1979

In this section we analyze two sets of accident data. The first, denoted "fatals," is the set of all drivers involved in all fatal accidents in Michigan during the years 1968 through 1979. The second, denoted the "20% sample," is a twenty-percent sample of drivers involved in any police-reported accident in Michigan during these years. (The sample is a 20% systematic sample with a random start within each year of accident data.) Some of the early years of the 20% sample were subject to some under-reporting from some jurisdictions. This has been discussed previously [2]. The effect on the rates, however, has been small. In any event, the current emphasis is on changes in accident occurrence coincident with the recent law change. Both sets of these police-reported data are complete for the most recent years.

For each set of data, the age-specific rates of alcohol involvement of drivers have been analyzed. The rates--the ratio of Had Been Drinking accidents to Had Been Drinking plus Had Not Been Drinking accidents--are denoted HBD rates. For accidents occurring each year, these age-specific rates have been compared. The chi-squared test has been used to judge whether variability of HBD rates exceeds random variation. The overall chi-squared statistic has also been partitioned into components, each of which is associated with a comparison of particular years.

For easy reference, the partitions are numbered as shown in Figure 1. In the figure, the arrows above each number indicate the years that are compared by the partition denoted by that number. Table 1 lists all of the partitions by number. However, it may be worthwhile to highlight some of the more important partitions.

Figure 1

Identification of Partitions by Years for Chi-squared Analysis

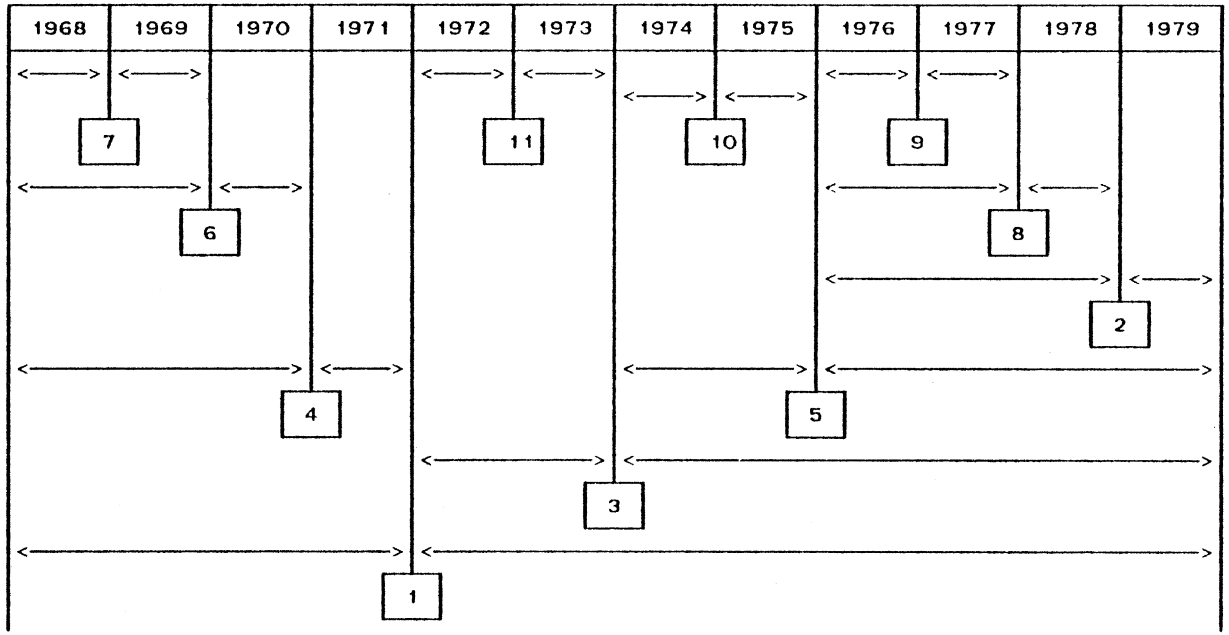

Table 1

List of Partitions

Partition Number	Years	Events or External Criteria
1	1968-1971 1972-1979	Corresponds to lowering of the legal drinking age
2	1976-1978 1979	Corresponds to raising the legal drinking age
3	1972-1973 1974-1979	Corresponds to FARS introduction, also an energy crisis and recession
4	1968-1970 1971	Corresponds to a change in reporting form
5	1974-1975 1976-1979	Compares the energy crisis with more recent years
6	1968-1969 1970	No external criteria
7	1968 1969	No external criteria
8	1976-1977 1978	No external criteria
9	1976 1977	No external criteria
10	1974 1975	No external criteria
11	1972 1973	No external criteria

Partition 1 compares the average rate during the years 1968 to 1971 with the average rate from 1972 through 1979. This corresponds to the lowering of the legal drinking age from 21 to 18 on January 1, 1972. Partition 2 compares the average rate of HBD in the years 1976 through 1978 with the rate in 1979. This corresponds to the raising of the legal drinking age from 18 to 19 (on

December 3, 1978) and from 19 to 21 (on December 23, 1978). There is an implicit assumption that the annual rates would not differ much if the last few days of 1978 are treated as though the legal drinking age remained at 18. Partition 3 corresponds to the introduction of the FARS (Fatal Accident Reporting System) and compares the average HBD rate in 1972 and 1973 with that during 1974-1979.[1] Partition 4, which compares the average HBD rate during 1968 through 1970 with the rate in 1971, corresponds to a change in the police accident data form. There are few other external criteria, although it is to be noted that the energy crisis and recession of 1974 corresponds with the introduction of FARS, and also that there was a recession in 1979.

2.1 Analysis of the Fatal Accident Data

Table 2 summarizes the significant partitions in the fatal data. In each case, the rates reported are HBD/(HBD+HNBD), where HNBD identifies the Had Not Been Drinking frequencies; these rates, therefore, exclude missing data on the HBD variable. Changes were judged significant at an age-group-wise 5% level, comparing the eleven partitions within a given age or age group. The partitioned chi-squared statistics were compared to 8.06 as the critical value for determining this group-wise significance rate, where the critical value was found using Bonferroni's method.

The most frequent significant partition was the partition that corresponds with the lowering of the legal drinking age in 1972. The HBD rates increased significantly at that time for ages 17, 18, 19, and 20, and for the groups 15-17, 18-20, 21-23, 24-26, 35-39, 45-49, and "All ages." This partition had

---

[1]The missing-data rate on the HBD variable exceeded 20% for 1968-1970 and was about 11% for 1971-1973. Following the introduction of FARS, the missing-data rate dropped to 1.2% in 1974 and has fluctuated around 2% since. As reported in [1], there is evidence that drinking involvement is somewhat higher among missing cases than among reported cases.

Table 2

Summary of Significant Partitions: Fatal Data

Age Group	Partition	Change in HBD Rate
16	1972-1973 vs. 1974-1979	.1314 to .2455
17	1968-1971 vs. 1972-1979	.1569 to .2747
18	1968-1971 vs. 1972-1979	.2290 to .3959
19	1968-1971 vs. 1972-1979	.2680 to .4363
	1972-1973 vs. 1974-1979	.3452 to .4673
20	1968-1971 vs. 1972-1979	.2730 to .4333
21	1972-1973 vs. 1974-1979	.3302 to .5000
26	1972 vs. 1973	.2364 to .4933
34	1976-1977 vs. 1978	.2644 to .5091
35-39	1968-1971 vs. 1972-1979	.2807 to .3480
45-49	1968-1971 vs. 1972-1979	.2278 to .3108
15-17	1968-1971 vs. 1972-1979	.1454 to .2438
	1972-1973 vs. 1974-1979	.1723 to .2702
18-20	1968-1971 vs. 1972-1979	.2546 to .4214
	1968-1969 vs. 1970	.2838 to .1868
	1972-1973 vs. 1974-1975	.3476 to .4455
21-23	1968-1971 vs. 1972-1979	.3851 to .4521
	1968-1969 vs. 1970	.4346 to .3082
	1972-1973 vs. 1974-1979	.3595 to .4803
24-26	1968-1971 vs. 1972-1979	.3579 to .4179
	1968-1969 vs. 1970	.4273 to .2656
All ages	1968-1971 vs. 1972-1979	.2770 to .3437
	1968-1970 vs. 1970	.3054 to .2270
	1972-1973 vs. 1974-1979	.2997 to .3591
	1976-1978 vs. 1979	.3507 to .3886

the largest sample sizes. The next most frequent significant change occurred with the introduction of FARS in 1974. Ages 16, 19, 21, and groups 15-17, 18-20, 21-23, and "All ages" showed significant increases in the HBD rates corresponding to this partition. A few other partitions showed significant changes. There was a significant increase from 1972 to 1973 among the 26-year-old drivers and a significant increase from 1976-77 to 1978 for the 34-year-old drivers. The 18-20, 21-23, and 24-26 year-old groups showed a significant decrease in HBD rate from 1968-1969 to 1970, as did all ages combined. Finally, all ages combined showed a significant increase in the HBD rate comparing 1976-1978 with 1979. Thus, while non-significant changes occurred in the HBD rates for individual ages and for the three-year age groups, for all ages combined there was an increase in HBD rate among fatal drivers in 1979. This general pattern of increase may have obscured any decrease or lack of change in HBD rate in the 18-to-20-year-old drivers, who could no longer drink legally in 1979.

Table 3 gives the direction of changes for all partitions and all ages, with "*" denoting those that were statistically significant. There was a substantial reduction in missing data with the introduction of FARS in 1974. As reported in [1], this appears to have acted to increase the reported HBD rates. Some of the increases in HBD rates corresponding to the lowering of the legal drinking age may be due in part to the fact that the average HBD rate from 1968 to 1971 is compared with the average rate from 1972 on, and this latter rate is somewhat increased as a result of the reduction in missing data.

For this study the primary question is what happened to the HBD rates in 1979 when the legal drinking age was increased to 21. This corresponds to partition number two. As summarized in Table 3, all of the changes in HBD rates in the fatal data corresponding to partition 2 were non-significant, but

most of the age groups showed increases in HBD rates in 1979. Over all ages the HBD rate increased significantly in 1979. Among drivers affected by the law change, the rate decreased only for the 18-year-old drivers. However, the HBD rate also decreased for 21-, 22-, and 25-year-olds among younger drivers, but all of these changes were non-significant.

It should be noted that although the HBD rates among the 18- to 20-year-old drivers involved in fatal crashes did not change much in 1979 relative to their earlier levels, the frequency of both HBD and HNBD involvements decreased. The frequency data for this age group, together with comparable data for other age groups, are given in Table 4.

It can be seen that the 15-17, 24-26, and "27 and older" groups all show the same general pattern. The 1979 HBD frequencies are higher than the earlier years, but the HNBD frequencies are lower. Significance at p=0.05 is achieved for the HNBD reductions among the two younger age groups and for the HBD increase among the 27 and older drivers.

The 18-20 and 21-23 groups differ from the three above and from each other as well. Among the 21-23 group the changes are small and non-significant. In contrast, the 18-20 drivers experienced a 10.5% reduction in HBD frequencies in 1979 compared to the earlier years, and a 16.9% reduction in the HNBD frequencies. The HBD reduction is not significant at the 5% level, but the associated two-sided probability is 0.18, indicating that a reduction of this size is likely to occur by chance only about one in five times. As indicated in the table, the HNBD reduction is significant at the 5% level.

The last two entries in Table 4 provide the data for all drivers combined except for those aged 18-20. For this group a statistically significant increase in HBD involvements occurred in 1979, and a significant decrease

Table 3

Summary of Changes in Fatal HBD Rates

Age Group	Partition Number										
	1	2	3	4	5	6	7	8	9	10	11
0-15	+	+	+	+	-	0	0	+	+	+	+
16	+	+	+*	+	+	+	+	-	-	+	-
17	+*	+	+	-	+	-	+	+	+	+	-
18	+*	-	+	+	-	+	-	-	-	+	-
19	+*	+	+*	+	-	-	-	-	-	+	+
20	+*	+	+	-	+	-	+	+	-	-	+
21	+	-	+*	+	-	-	-	-	-	+	+
22	+	-	+	+	+	-	-	+	-	+	+
23	+	+	+	-	-	-	+	+	-	-	+
24	+	+	+	-	+	-	+	+	+	-	-
25	+	-	+	-	+	-	+	-	-	-	-
26	+	+	+	-	-	-	+	+	+	+	+
27	+	+	+	+	+	-	+	-	-	-	-
28	+	-	+	+	+	-	-	-	+	+	-
29	+	+	+	-	+	-	+	+	-	-	-
30	-	+	-	-	-	-	0	-	+	-	-
31	+	+	+	0	+	-	-	+	-	+	+
32	+	+	+	+	-	-	+	+	+	+	+
33	+	-	-	+	-	-	-	-	+	-	-
34	-	+	+	+	+	-	-	+	+	+	+*
35-39	+*	+	+	+	-	-	-	+	+	+	+
40-44	+	-	-	-	+	-	+	-	-	-	-
45-49	+*	-	+	-	+	-	-	-	-	+	+
50-54	+	+	+	+	-	-	-	-	+	-	+
55-59	-	0	-	+	+	-	+	0	+	+	+
60-64	-	+	-	+	-	-	+	-	-	+	+
65+	+	+	+	-	-	-	+	+	+	-	-
15-17	+*	+	+*	+	+	-	+	-	+	+	-
18-20	+*	+	+*	+	+	-*	+	+	-	+	+
21-23	+*	-	+*	+	-	-*	-	+	-	+	+
24-26	+*	+	+	-	+	-*	+	+	+	-	+
All	+*	+*	+*	+	+	-*	-	-	+	+	+

The "+" indicates that the rate increased in the latter period, "-" that the rate decreased, and "0" that the rates were the same to three decimals. The "*" denotes that the change was statistically significant at the row-wise simultaneous 5% level (chi-squared exceeded 8.07). Partitions are diagrammed in Figure 1 and listed in Table 1.

Table 4

HBD and HNBD Frequencies by Age Group
1974-1978 Mean and 1979

Age Group	Variable	1974-78 (Mean)	1979	% Change	*Signif.
15-17	HBD	49.2	55	+11.8	No
	HNBD	140.4	111	-20.9	Yes
18-20	HBD	178.8	160	-10.5	No
	HNBD	225.0	187	-16.9	Yes
21-23	HBD	144.8	142	-2.9	No
	HNBD	155.4	160	+3.0	No
24-26	HBD	98.6	106	+7.5	No
	HNBD	136.2	113	-17.0	Yes
27 and older	HBD	386.2	458	+18.6	Yes
	HNBD	912.4	878	-3.7	No
All excl. 18-20	HBD	678.8	761	+12.1	Yes
	HNBD	1344.4	1262	-6.0	Yes

*The statistical tests assume that the frequencies follow a Poisson distribution. Significance is indicated at p=0.05 (two-tailed test) using a normal approximation.

occurred in HNBD involvements. The HNBD change is in the same direction as for the 18-20 group, but the increase in HBD's is opposite to the reduction in HBD's for the 18-20 group.

Considered together, these findings indicate that the fatal accident experience of the 18- to 20-year-old drivers is consistent with a reduction in alcohol-related crashes associated with the increased legal drinking age in 1979. But it is also clear that other factors are operative which have reduced the HNBD experience as well. The concurrent reductions in both HBD and HNBD

frequencies have resulted in little change in the HBD rate of the affected age group in this first year of the higher legal drinking age. The trends noted here should be monitored for several years so that the steady-state effect of the law change can be established after the transient effects have dissipated.

2.2 Analysis of the 20% Sample Accident Data

The same approach to partitioning the chi-squared statistic into its eleven degrees of freedom was used on data from the 20% sample of all reported accidents. Some general features of these data differ from the fatal data. First of all, there are many more accidents than fatal accidents, so that the frequencies that these rates are based on are much larger, even when only a 20% sample is used rather than all of the accidents. Secondly, the HBD rates are much lower in the 20% sample data than they are in the fatal data. The HBD rates in the 20% sample are on the order of 10%, ranging roughly from 5% to 15%, whereas they ranged from about 20% to 45% for most groups in the fatal data.

Because of the much larger sample sizes, many more of the partitions were significant in the 20% data than were significant in the fatal data. Table 5 summarizes the directions of the changes corresponding to all the partitions and all of the age groups. The partition numbers are the same as for the fatal data and were presented in Table 1. Again, a "+" denotes an increase in the later years, a "-" denotes a decrease, and a "0" denotes that the rates were unchanged to three decimals. The significant changes are denoted by "*".

Table 6 summarizes all of the significant partitions, giving for each age group, the year groupings compared and the change in average HBD rate corresponding to that partition. While the significant partitions are too numerous to detail, certain common patterns occur. A significant increase in HBD rate occurred corresponding to the lowering of the legal drinking age for

Table 5

Summary of Changes in 20% Sample HBD Rates

Age Group	Partition Number										
	1	2	3	4	5	6	7	8	9	10	11
0-15	+	-	+	-	-	+	-	-	+	-	-
16	+*	-	+*	+	+	+	0	-	-	+	-
17	+*	-	+*	-	+	+	0	-	-	+*	+
18	+*	-*	+*	-	+	0	-	-	+	+	0
19	+*	-*	+*	-	+	-	+	-	-	+*	-
20	+*	-*	+*	-*	+	-	+	+	-	+*	+
21	-	+*	+*	-*	+	-*	-*	+	+	+	+
22	-*	+*	+*	-*	+	-*	0	-	-	+*	-
23	-	+	+*	-	+	-*	-	-	+	-	+
24	-*	+*	+*	-	+	-*	-	+	-	+	+
25	-*	+	+*	-	+	-*	+	0	+	+	+
26	-*	+	+	-	-	-*	+	0	+	+	-
27	-*	+	+*	-	+	-*	-	+	+	+	-
28	-*	+	+	-	-	-*	+	+	+	+	-
29	-*	+	+	-	-	-*	-	-	-	+	+
30	-*	+	+	-	-*	-	-	+	-	-	-
31	-*	+	+	-	-	-	+	+	-	-	-
32	-*	+*	+	-	-	-	-	-	+	-	-
33	-*	+	-	-	-	-	-	-	+	+	-
34	-	+	-	-	-*	-	-	0	-	-	-
35-39	-*	+	-*	-	-*	-*	+	-	-	-	-
40-44	-*	0	-*	-	-*	-*	+	-	-	0	-
45-49	-	+	-	-	-*	-*	+	-	-	+	+
50-54	-	0	-*	-	-*	-	-	-	-	0	0
55-59	-*	-	-	-	-	-	+	+	+	0	-
60-64	-	+	-	-	-	-	-	-	-	+	-
65+	-*	+	-	-	-	-	-	-	+	-	+
15-17	+*	-	+*	-	+	+	-	-*	-	+	+
18-20	+*	-*	+*	-	+	-	+	-	-	+*	+
21-23	-*	+*	+*	-*	+*	-*	-	-	+	+	+
24-26	-*	+*	+*	-*	+	-*	-	+	-	+	+
All	+	+*	+*	-*	-*	-*	-	-	-	+*	-

The "+" indicates that the rate increased in the latter period, "-" that the rate decreased, and "0" that the rates were the same to three decimals. The "*" denotes that the change was statistically significant at the row-wise simultaneous 5% level (chi-squared exceeded 8.07). Partitions are diagrammed in Figure 1 and listed in Table 1.

ages under 21 and only for those ages. This agrees with the findings from the fatal data. For many of the ages over 21, a significantly low HBD rate occurred in 1970.

The raising of the legal drinking age in 1979 corresponds to a significant drop in the HBD rate for ages 18, 19, 20, while a significant increase in the HBD rate occurred at this time for many of the older age groups, specifically, ages 21, 22, 24, 32, 21-23, 24-25, and all ages. Thus, when the legal drinking age was raised, significant reductions in the HBD rates for the 18-20 year old drivers were observed, while at the same time significant increases in the HBD rates were observed for the slightly older drivers. Various interpretations are possible. The fact that the HBD rate for 18- to 20-year-old drivers decreased significantly when the drinking age was raised, while the HBD rate for 21- to 26-year-old drivers increased, may mean that there was a general increase in HBD and that the observed reduction for young drivers was not as large as the real reduction. Another interpretation is that the effect of the law change was to reduce drinking and driving among the 18- to 20-year-old drivers, but to shift some of this to the next older drivers. Possibly a combination of the two or of some other causes occurred.

It is interesting to note that a reversed pattern occurs, corresponding to the lowering of the legal drinking age. At that time, HBD rates increased only for the young drivers, with significant increases for ages 16 to 20, while HBD rates for older drivers decreased. Significant decreases occurred in many of the older age groups. This suggests that the legal change may have affected both the 18-20 year old drivers and the slightly older ones, but changed their HBD rates in opposite directions.

Table 6

Summary of Significant Partitions: 20% Sample Data

Age Group	Partition	Change in HBD Rate
16	1968-1971 vs. 1972-1979	.0285 to .0406
	1972-1973 vs. 1974-1979	.0297 to .0442
17	1968-1971 vs. 1972-1979	.0372 to .0608
	1972-1973 vs. 1974-1979	.0500 to .0642
	1976 vs. 1977	.0545 to .0685
18	1968-1971 vs. 1972-1979	.0501 to .1113
	1972-1973 vs. 1974-1979	.0931 to .1174
	1976-1978 vs. 1979	.1259 to .0953
	1974 vs. 1975	.1025 to .1262
19	1968-1971 vs. 1972-1979	.0642 to .1184
	1972-1973 vs. 1974-1979	.0953 to .1258
	1976-1978 vs. 1979	.1326 to .1082
	1974 vs. 1975	.1086 to .1379
20	1968-1971 vs. 1972-1979	.0744 to .1228
	1968-1970 vs. 1971	.0808 to .0612
	1972-1973 vs. 1974-1979	.1060 to .1283
	1976-1978 vs. 1979	.1336 to .1192
	1974 vs. 1975	.1138 to .1337
21	1968-1970 vs. 1971	.1469 to .1110
	1968-1969 vs. 1970	.1623 to .1198
	1972-1973 vs. 1974-1979	.1000 to .1345
	1976-1978 vs. 1979	.1300 to .1559
22	1968-1971 vs. 1972-1979	.1385 to .1254
	1968-1970 vs. 1971	.1460 to .1203
	1968-1969 vs. 1970	.1591 to .1266
	1972-1973 vs. 1974-1979	.1060 to .1319
	1976-1978 vs. 1979	.1278 to .1553
	1976 vs. 1977	.1113 to .1377
23	1968-1969 vs. 1970	.1527 to .1202
	1972-1973 vs. 1974-1979	.1104 to .1295
24	1968-1971 vs. 1972-1979	.1298 to .1147
	1968-1969 vs. 1970	.1430 to .1122
	1972-1973 vs. 1974-1979	.1014 to .1190
	1976-1978 vs. 1979	.1158 to .1365

Table 6 - Continued
Summary of Significant Partitions: 20% Sample Data

Age Group	Partition	Change in HBD Rate
25	1968-1971 vs. 1972-1979	.1347 to .1169
	1968-1969 vs. 1970	.1543 to .1218
	1972-1973 vs. 1974-1979	.1062 to .1205
26	1968-1971 vs. 1972-1979	.1296 to .1136
	1968-1969 vs. 1970	.1502 to .1085
27	1968-1971 vs. 1972-1979	.1366 to .1137
	1968-1969 vs. 1970	.1596 to .1147
	1972-1973 vs. 1974-1979	.1017 to .1170
28	1968-1971 vs. 1972-1979	.1330 to .1162
	1968-1969 vs. 1970	.1532 to .1152
29	1968-1971 vs. 1972-1979	.1344 to .1142
	1968-1969 vs. 1970	.1530 to .1210
30	1968-1971 vs. 1972-1979	.1309 to .1114
	1974-1975 vs. 1976-1979	.1274 to .1069
31	1968-1971 vs. 1972-1979	.1353 to .1121
32	1968-1971 vs. 1972-1979	.1321 to .1145
	1976-1978 vs. 1979	.1070 to .1295
33	1968-1971 vs. 1972-1979	.1394 to .1173
34	1974-1975 vs. 1976-1979	.1287 to .1073
35-39	1968-1971 vs. 1972-1979	.1282 to .1146
	1968-1969 vs. 1970	.1378 to .1138
	1972-1973 vs. 1974-1979	.1212 to .1123
	1974-1975 vs. 1976-1979	.1220 to .1084
40-44	1968-1971 vs. 1972-1979	.1310 to .1120
	1968-1969 vs. 1970	.1459 to .1163
	1972-1973 vs. 1974-1979	.1211 to .1084
	1974-1975 vs. 1976-1979	.1217 to .1023
45-49	1968-1969 vs. 1970	.1308 to .0991
	1974-1975 vs. 1976-1979	.1143 to .1032
50-54	1972-1973 vs. 1974-1979	.1030 to .0939
	1974-1975 vs. 1976-1979	.1047 to .0889
55-59	1968-1971 vs. 1972-1979	.0969 to .0841
65-69	1968-1971 vs. 1972-1979	.0525 to .0425

Table 6 - Continued
Summary of Significant Partitions: 20% Sample Data

Age Group	Partition	Change in HBD Rate
15-17	1968-1971 vs. 1972-1979	.0339 to .0528
	1972-1973 vs. 1974-1979	.0418 to .0563
	1976-1977 vs. 1978	.0616 to .0535
18-20	1968-1971 vs. 1972-1979	.0615 to .1171
	1972-1973 vs. 1974-1979	.0976 to .1235
	1976-1978 vs. 1979	.1304 to .1069
	1974 vs. 1975	.1078 to .1323
21-23	1968-1971 vs. 1972-1979	.1359 to .1255
	1968-1970 vs. 1971	.1441 to .1173
	1968-1969 vs. 1970	.1586 to .1223
	1972-1973 vs. 1974-1979	.1052 to .1321
	1974-1975 vs. 1976-1979	.1263 to .1345
	1976-1978 vs. 1979	.1287 to .1518
24-26	1968-1971 vs. 1972-1979	.1313 to .1151
	1968-1970 vs. 1971	.1357 to .1219
	1968-1969 vs. 1970	.1491 to .1143
	1972-1973 vs. 1974-1979	.1044 to .1185
	1976-1978 vs. 1979	.1157 to .1298
	1974 vs. 1975	.1096 to .1240
All Ages	1968-1970 vs. 1971	.1065 to .0942
	1968-1969 vs. 1970	.1138 to .0946
	1972-1973 vs. 1974-1979	.0977 to .1049
	1974-1975 vs. 1976-1979	.1066 to .1042
	1976-1978 vs. 1979	.1032 to .1072
	1974 vs. 1975	.1031 to .1100

The 20% sample data show rather different patterns than do the fatal data. Most of the fatal HBD rates corresponding to the partition at 1971 showed increases, but these were only significant in the young drivers, while the young drivers' rates increased and older drivers' HBD rates decreased in the 20% data. Considering changes in HBD rates in 1979, nearly all of the ages in the fatal data show increases, with older drivers showing significant increases and younger drivers non-significant increases. On the other hand, in the 20%

sample data, significant decreases are observed for younger drivers, while most older ages show increases and the ages immediately older than 20 show significant increases.

Thus, in the 20% sample data, drivers in the age groups directly affected by the law change showed significant reductions in their HBD rate, while at the same time older drivers, particularly those only slightly older, showed significant increases in HBD rates. This finding argues that the change in HBD rates may have been caused by the law change. In the fatal data, a different pattern was observed. Only the 18-year-old drivers showed a reduction in the HBD rate in 1979; the 19, 20, and slightly older drivers all showed significant increases in their HBD rates. All of these changes in the fatal data were non-significant, and so could be ascribed to chance.

2.3 Analysis of Cohort HBD Rates

With data on individual age groups for 12 years, it is possible to define cohorts of drivers and follow their HBD rates over a number of years. This was introduced by Flora, Filkins, and Compton [1]. In the present study such cohorts may be followed in both the fatal data and the 20% sample of police-reported accidents.

In this investigation, we define cohorts by the age of the driver in 1979. This seems preferable to defining them by the age in 1968, the first year of the data, since the event of most interest--raising the legal drinking age--took place in 1979. Thus, most interest is in the later data rather than the earlier data. The effect on the lowering of the drinking age in 1972, of the introduction of FARS in 1974, etc., were investigated in the fatal data in the earlier report [1].

For each cohort defined by the drivers' ages in 1979, the HBD rate was calculated for each year. These rates can be observed in Table 7 for the fatal data or in Table 8 for the 20% sample data by proceeding diagonally. As one adds one year to the date at the top of the table, one drops one row to add one year of age. The chi-squared (X^2) statistic calculated for the several years of following a cohort can be partitioned to investigate when significant changes in the HBD rates occurred. The set of partitions varies with the cohort. For example, the cohort that was age 20 in 1979 could drink legally at ages 18 and 19, but not at age 20. This suggests a comparison of the HBD rates at ages 16 and 17, before they could drink legally, at ages 18 and 19, when they could drink legally and at age 20, when they could no longer drink legally. This example has 5 years of data, thus having an overall chi-squared statistic with 4 degrees of freedom. Other cohorts have more or fewer degrees of freedom and may have different partitions of interest.

Age 17 in 1979

This cohort exhibits, in Table 9, significant increases in HBD rate in 1979, for both fatal (X^2=7.03, 1 d.f.) and 20% data (X^2=22.21, 1 d.f.) corresponding to their change in age from 16 to 17. Both increases were substantial (108% and 53%), but the 20% sample rate is still relatively low.

Age 18 in 1979

The fatal data, shown in Table 10, show marginally significant differences in HBD rates (X^2=5.74, 2 d.f., .05<p<.10). The HBD rate increased with age in this cohort, with the largest increase from age 17 to 18. Partitioning the chi-squared statistic shows that the HBD rates are not significantly different for the 16 and 17 year olds (X^2=0.50) at the cohort-wise 5% level. However, the 18-year-old rate (.4000) is significantly higher than the rate for the combined 16-17 age group (X^2=5.23).

Table 7

HBD Rates of Drivers in the Michigan Fatal Files, 1968-1979

AGE	YEAR											
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1-15	-0-	-0-	-0-	.0667	.0476	.1000	.2727	.1875	-0-	.1333	.1000	.2222
16	.0426	.1833	.1702	.2069	.1410	.1186	.1719	.3265	.2838	.2468	.1714	.3019
17	.1705	.1889	.1310	.1548	.2248	.2000	.2661	.2936	.2642	.3118	.2951	.3558
18	.2185	.2769	.1724	.2885	.3507	.3167	.3946	.4403	.4467	.4079	.3953	.4000
19	.3061	.2913	.2710	.2804	.3311	.3609	.4242	.5221	.5379	.4213	.4211	.4793
20	.3125	.3204	.2603	.2600	.3182	.4048	.4528	.4125	.4538	.3786	.5159	.5094
21	.4538	.3670	.4070	.4167	.3220	.3404	.5000	.5976	.5268	.4476	.4809	.4737
22	.4747	.4388	.4720	.4100	.3605	.4021	.4333	.5238	.5278	.4494	.5405	.4574
23	.4030	.4691	.4458	.3723	.2933	.4487	.4684	.4434	.4396	.4124	.4301	.4787
24	.4444	.4146	.4035	.2887	.3704	.3646	.4328	.3864	.3605	.3978	.4167	.5116
25	.4286	.4627	.3478	.3478	.3974	.3919	.4478	.3729	.5176	.4615	.4588	.4714
26	.3582	.4494	.3333	.3382	.2364	.4933	.4079	.4697	.2951	.4167	.4337	.4603
27	.2273	.4688	.3860	.3582	.4030	.3448	.4603	.3625	.6275	.4024	.3750	.4571
28	.3448	.3333	.3333	.4528	.4545	.3390	.3019	.4118	.5294	.5763	.4688	.3548
29	.2571	.4783	.4800	.3077	.4063	.2407	.3953	.3488	.3750	.3704	.4875	.5616
30	.4400	.4400	.3636	.3571	.4643	.3793	.4118	.3333	.3125	.3594	.3016	.3784
31	.4839	.3448	.2917	.3200	.2222	.3000	.3774	.4000	.3830	.3182	.4394	.5185
32	.3256	.3953	.2895	.3333	.3256	.3725	.3529	.5000	.3182	.4242	.3673	.4400
33	.3571	.2500	.3125	.2917	.4390	.4043	.4091	.3659	.3750	.3958	.3261	.3409
34	.4615	.3111	.3939	.5200	.2432	.4250	.2333	.3514	.2326	.2955	.5091	.5000
35-39	.3077	.2898	.2959	.3099	.3246	.3642	.4000	.4103	.2886	.3000	.2984	.3981
40-44	.3274	.3444	.3702	.2456	.3235	.3095	.2971	.2966	.3382	.2879	.3099	.3115
45-49	.3038	.2299	.2692	.1732	.2516	.2619	.3197	.3302	.3719	.3306	.3233	.3396
50-54	.3000	.2532	.2687	.2901	.2241	.2778	.2705	.2642	.2712	.2963	.2031	.2927
55-59	.2255	.2650	.2340	.3010	.2326	.2447	.1856	.2439	.1928	.2400	.2190	.2184
60-64	.2027	.2055	.1385	.2625	.2118	.2353	.2198	.2456	.1733	.1596	.0989	.2105
65-98	.1049	.1099	.0974	.0774	.1106	.0882	.1511	.0602	.0585	.0919	.1205	.1417
Unk.	-0-	-0-	-0-	.2500	.3333	-0-	-0-	.3333	.4545	.3333	.3333	.4286
15-17	.1206	.1728	.1357	.1656	.1798	.1630	.2362	.2931	.2606	.2703	.2426	.3313
18-20	.2705	.2946	.2297	.2765	.3342	.3615	.4208	.4657	.4807	.4043	.4500	.4611
21-23	.4491	.4201	.4456	.4000	.3262	.3941	.4686	.5154	.5016	.4364	.4866	.4702
24-26	.4115	.4412	.3616	.3205	.3458	.4122	.4286	.4085	.4009	.4235	.4356	.4840
All	.3033	.3073	.2936	.2813	.2892	.3104	.3471	.3693	.3609	.3395	.3521	.3886

Table 8

HBD Rates of Drivers in the Michigan 20% Sample Files, 1968-1979

AGE	YEAR											
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
1-15	.0511	.0408	.0621	.0216	.0483	.0390	.0734	.0521	.0669	.0727	.0579	.0436
16	.0271	.0271	.0315	.0289	.0305	.0291	.0376	.0413	.0541	.0464	.0412	.0442
17	.0375	.0372	.0398	.0363	.0481	.0518	.0545	.0685	.0696	.0680	.0614	.0632
18	.0517	.0507	.0540	.0476	.0931	.0930	.1025	.1262	.1264	.1330	.1188	.0953
19	.0633	.0663	.0689	.0630	.0969	.0938	.1086	.1379	.1383	.1275	.1321	.1082
20	.0843	.0847	.0804	.0612	.1021	.1099	.1138	.1337	.1345	.1306	.1357	.1192
21	.1771	.1473	.1361	.1110	.0981	.1021	.1246	.1349	.1241	.1349	.1306	.1559
22	.1590	.1591	.1449	.1203	.1084	.1038	.1113	.1377	.1363	.1238	.1242	.1553
23	.1578	.1479	.1366	.1211	.1066	.1143	.1249	.1232	.1267	.1319	.1256	.1430
24	.1519	.1340	.1264	.1275	.0965	.1065	.1071	.1216	.1154	.1095	.1225	.1365
25	.1509	.1578	.1388	.1189	.1017	.1109	.1098	.1248	.1176	.1212	.1204	.1278
26	.1477	.1523	.1217	.1174	.1095	.1034	.1123	.1259	.1102	.1117	.1116	.1243
27	.1672	.1527	.1296	.1264	.1048	.0985	.1068	.1126	.1109	.1156	.1252	.1284
28	.1454	.1603	.1302	.1230	.1132	.1114	.1193	.1211	.1026	.1101	.1211	.1300
29	.1580	.1485	.1377	.1224	.1107	.1145	.1155	.1187	.1202	.1100	.1019	.1243
30	.1470	.1461	.1495	.1123	.1096	.1069	.1293	.1255	.1046	.0989	.1057	.1182
31	.1397	.1605	.1480	.1199	.1118	.1077	.1247	.1121	.1134	.1012	.1099	.1161
32	.1629	.1346	.1413	.1159	.1191	.1077	.1191	.1159	.1058	.1149	.1009	.1295
33	.1606	.1444	.1413	.1337	.1257	.1106	.1134	.1264	.1116	.1203	.1146	.1166
34	.1628	.1329	.1268	.1131	.1261	.1176	.1348	.1227	.1100	.0992	.1045	.1165
35-39	.1363	.1392	.1284	.1266	.1238	.1184	.1239	.1201	.1109	.1054	.1060	.1115
40-44	.1444	.1473	.1316	.1223	.1241	.1177	.1218	.1216	.1120	.0965	.0989	.1019
45-49	.1231	.1376	.1100	.1130	.1142	.1156	.1133	.1153	.1046	.1037	.0967	.1081
50-54	.1122	.1098	.1114	.0958	.1028	.1033	.1045	.1048	.0933	.0887	.0843	.0894
55-59	.1026	.1078	.0996	.0905	.0935	.0872	.0892	.0887	.0751	.0806	.0825	.0767
60-64	.0869	.0795	.0785	.0696	.0758	.0721	.0680	.0744	.0701	.0605	.0562	.0733
65-98	.0607	.0561	.0504	.0484	.0402	.0463	.0486	.0454	.0409	.0413	.0343	.0452
Unk.	.2249	.2199	.1883	.0685	.1189	.1525	.1362	.1039	.1340	.1152	.1160	.1162
15-17	.0338	.0334	.0370	.0329	.0412	.0422	.0485	.0574	.0635	.0598	.0535	.0551
18-20	.0642	.0648	.0661	.0567	.0970	.0982	.1078	.1323	.1328	.1304	.1283	.1069
21-23	.1662	.1518	.1393	.1173	.1040	.1064	.1202	.1322	.1289	.1303	.1270	.1518
24-26	.1503	.1480	.1291	.1219	.1019	.1070	.1096	.1240	.1145	.1140	.1183	.1298
All	.1150	.1128	.1045	.0942	.0982	.0972	.1031	.1100	.1054	.1028	.1016	.1072

Table 9

Cohort Analysis: Age 17 in 1979

Age	Data File	
	Fatal	20% Sample
16	.1714	.0412
17	.3558	.0632

The 20% sample data exhibit significant differences in the rates (X^2=98.58, 2 d.f.). Partitioning this into the difference between ages 16 and 17 gives a significant X^2 (8.13) with a larger difference occurring between the combined 16 and 17 rates and the 18-year-old rate (X^2=90.46). This cohort shows a steady increase in HBD rate with age in the sample data.

Table 10

Cohort Analysis: Age 18 in 1979

Age	Data File	
	Fatal	20% Sample
16	.2468	.0464
17	.2951	.0614
18	.4000	.0953

Age 19 in 1979

This cohort, shown in Table 11, is of special interest because it represents a cohort that could not drink legally at 16 or 17, could drink legally at 18 in 1978, then could no longer drink legally at 19 in 1979.

Table 11

Cohort Analysis: Age 19 in 1979

Age	Data File	
	Fatal	20% Sample
16	.2838	.0541
17	.3118	.0680
*18	.3953	.1188
19	.4793	.1082

The "*" denotes legal drinking.

The two data sets exhibit a different pattern of HBD rates. In the fatal data the HBD rate increased with each year of age, while in the 20% sample the HBD rate shows a sharp increase at age 18 with little difference between age 18 and 19 or between age 16 and 17. In the fatal data the overall $X^2=9.92$ with 3 d.f., significant at $p<.05$. Partitioning the data first to compare rates at ages 16 and 17 with the rate at 18 and 19 gives a X^2 of 7.92, significant at the (cohort-wise) 5% level. Completing the partitioning by comparing the rates for ages 18 with 19 gave $X^2=1.87$, not significant, and the comparison between ages 16 and 17 gave $X^2=0.14$, also not significant. Thus, while there appears to be a steady increase in HBD rate with age, the data also support a large increase at age 18, with no decrease, in fact, a nonsignificant but large further increase at age 19.

Partitioning the 20% sample data in the same way gives a $X^2=171.33$ for the comparison before and after age 18. The difference between ages 16 and 17 has a $X^2=5.20$ while the slight decrease at age 19 has a $X^2=4.19$. Neither of these reaches the critical value of 5.74 for the cohort-wise 5% level.

Both data sets show substantial increases when the cohort became old enough to drink legally. The HBD rate in the fatal data continued to increase at age 19 even though drinking was no longer legal. In the 20% sample data a small, but not statistically significant ($X^2=4.19$), reduction in the HBD rate occurred when this group could no longer drink legally.

Age 20 in 1979

This cohort also was able to drink legally (at age 18 and 19) and then had that privilege withdrawn (at age 20). Table 12 shows that the HBD rate in the fatal data had a sharp increase at age 18, with continued increases at age 19 and particularly at age 20. The 20% sample data shows a similarly sharp increase at age 18, but no further increase. In fact, a slight decrease occurred when the drinking privilege was withdrawn.

Table 12

Cohort Analysis: Age 20 in 1979

Age	Data File	
	Fatal	20% Sample
16	.3265	.0413
17	.2642	.0696
*18	.4079	.1330
*19	.4211	.1321
20	.5094	.1192

The "*" denotes legal drinking.

The fatal data have an overall $X^2=14.80$ (4 d.f., $p<.05$). Partitioning the data at age 18 gives $X^2=11.29$ ($p<.05$). Comparison of ages 16 and 17 gives $X^2=0.55$, not significant. Within the ages 18-20, comparing age 20 (drinking no

longer legal) with ages 18 and 19 (legal drinking) gave $X^2=2.92$, not significant. The final comparison of ages 18 and 19 gave $X^2=0.05$, also not significant.

The 20% sample had a total $X^2=338.23$ (4 d.f., p=0.000). Partitioning this table in the same manner gave $X^2=313.08$ (p=.000) for the pre- and post-age 18 comparison. A significant difference was also found between the HBD rates at age 16 and 17 ($X^2=18.2$). Ages 18 and 19 did not differ significantly (both legal to drink; $X^2=0.03$). However, the decrease in HBD rates concurrent with the change in law was significant at the 5% level ($X^2=6.93$ $p<.05$).

There seems to be an indication that the change in law was more apparent in the 20% sample data than in the fatal data. Certainly different patterns of HBD rates are observed.

Age 21 in 1979

This cohort did not have its drinking privilege interrupted. The HBD rates in Table 13 show sharp increases at age 18 when the cohort could first drink legally. Generally HBD rates are about the same beyond age 18. The pattern again differs between the fatal and 20% sample data. The fatal data show a peak at age 20, while the 20% sample data show an increase from age 20 to 21.

The fatal data have a total $X^2=31.06$ (5 d.f., $p<.01$). Partitioning the table results in only one significant result ($X^2=25.30$), corresponding to attaining the legal drinking age at 18. Differences among ages 18-21 are non-significant as is the difference between HBD rates for ages 16 and 17.

The 20% sample data have a total $X^2=442.55$ (5 d.f., p=0.0000). Partitioning this table shows that the major change coincides with attainment of the legal drinking age ($X^2=393.54$). However the difference in HBD rates between ages 16 and 17 is also significant ($X^2=19.79$). Further, the increase

Table 13

Cohort Analysis: Age 21 in 1979

Age	Data File	
	Fatal	20% Sample
16	.1719	.0376
17	.2936	.0685
*18	.4467	.1264
*19	.4213	.1275
*20	.5159	.1357
*21	.4737	.1559

The "*" denotes legal drinking.

in HBD at age 21 is significant (X^2=26.25), showing that the rate at age 21 is significantly higher than at ages 18-20. Ages 19-20 showed no significant differences.

Age 22 in 1979

This cohort (Table 14) exhibits similar patterns in the fatal and sample HBD rates. Both data sets show a sharp increase at age 18 corresponding to legal drinking. Thereafter, rates are relatively constant. As with the 21-in-79 cohort, the 20% sample HBD rate increased in 1979, while the fatal HBD rate decreased.

The fatal data show a significant overall chi-squared statistic (X^2=45.89, 6 d.f., p=0.0000). Partitioning this table shows that only the partition corresponding to age 18 (legal drinking) is significant (X^2=34.33). No further differences among ages 18-22 or between ages 16 and 17 were significant.

The 20% sample data showed an overall chi-squared statistic that was also highly significant (X^2=597.99, 6 d.f., p=0.0000). Partitioning this showed that the most significant change in HBD rates occurred corresponding to the

Table 14

Cohort Analysis: Age 22 in 1979

Age	Data File	
	Fatal	20% Sample
16	.1186	.0291
17	.2661	.0545
*18	.4403	.1262
*19	.5379	.1383
*20	.3786	.1306
*21	.4809	.1306
*22	.4574	.1553

The "*" denotes legal drinking.

legal drinking age (X^2=558.48). However, the difference between ages 16 and 17 was also significant (X^2=13.47), as was the difference between age 22 and ages 18-21 (X^2=21.66).

Age 23 in 1979

This cohort (Table 15) also exhibits the typical pattern of HBD rates for cohorts who became legally able to drink at age 18 and have maintained that privilege. A sharp increase in HBD rate occurred at the time of enfranchisement, with relatively constant rates since then. The most recent year showed a slight reduction in fatal HBD rate but a slight increase in 20% sample HBD rate.

The overall chi-squared statistic was significant in the fatal data (X^2=60.88, 7 d.f., p=0.0000). Partitioning this showed that most of the differences could be associated with the legal enfranchisement (X^2=52.60). None of the other partitions was significant at the joint 5% level. The largest was for the difference in rates between 1974 and 1975 (or ages 18 and 19) (X^2=4.75 compared to the cohort-wise 5% critical value of 7.26).

Table 15

Cohort Analysis: Age 23 in 1979

Age	Data File	
	Fatal	20% Sample
16	.1410	.0305
17	.2000	.0518
*18	.3946	.1025
*19	.5221	.1379
*20	.4538	.1345
*21	.4476	.1349
*22	.5405	.1242
*23	.4787	.1430

The "*" denotes legal drinking.

In the 20% sample data the overall chi-squared test was highly significant (X^2=581.16, 7 d.f., p=0.000). Again most of the difference could be associated with the age of enfranchisement (X^2=512.67). However, four other partitions were also significant at the cohort-wise 5% level. There was a significant increase from age 16 to age 17 (X^2=9.97). A significant increase occurred in comparing ages 18 and 19 with the ages 20-23 (X^2=15.06). The HBD rate at age 19 was larger than at age 18 (X^2=35.37). Finally, the higher HBD rate in 1979 compared to 1978 (age 23 compared to age 22) was significant (X^2=7.92).

Age 24 in 1979

This cohort, as seen in Table 16, again shows a sharp increase in HBD rates concurrent with attaining the legal drinking age. This increase appears to continue over 2 years (fatal) or 3 years (20% sample). An additional difference here is that both data sets showed an increase in HBD rate in 1979.

Table 16

Cohort Analysis: Age 24 in 1979

Age	Data File	
	Fatal	20% Sample
16	.2069	.0289
17	.2248	.0481
*18	.3167	.0930
*19	.4242	.1086
*20	.4125	.1337
*21	.5268	.1241
*22	.4494	.1238
*23	.4301	.1256
*24	.5116	.1365

The "*" denotes legal drinking.

The fatal data had an overall highly significant X^2 (X^2=42.59, 8 d.f., p=0.0000). Most of the difference in HBD rates was associated with the increase in HBD rate at the time the cohort became legally able to drink (in 1973 at age 18) (X^2=29.07). One other partition was nearly significant, with the 21-24 group having a higher rate than the 18-20 group (1976-1979 vs. 1973-1975, X^2=7.30 compared to the joint 5% critical value of 7.51).

The 20% sample data show significant overall differences in HBD rates (X^2=503.52, 8 d.f., p=0.000). In addition, several of the partitions were significant at the cohort-wise 5% level. The largest differences occurred when comparing ages 16 and 17 to ages 18-23. The increase in HBD rate for the older ages was significant (X^2=417.05). In addition, the HBD rate increased significantly from 1973 to 1974 and 1975 (ages 18 compared to 19 and 20) (X^2=31.13); the rate for age 20 is also higher than for 19 (X^2=16.33). There

was also a significant increase in HBD rate for ages 21-24 compared to ages 18-20. (X^2=27.05). Finally, the increase in 1979 compared to 1978 was nearly significant (X^2=7.29 compared to the critical value of 7.51).

Summary of Cohort Analysis Results

In a previous study [1] cohort HBD rates for fatals were investigated. That study used cohorts defined by ages about 18-20 in 1971 or 1972, corresponding to the lowering of the legal drinking age. The results showed that an increase in HBD rate occurred consistently when that cohort could first drink legally, whether at age 18, 19, 20, or 21.

The present data also show a strong increase in HBD rate when the cohort attains the legal drinking age. Two of the younger cohorts had the drinking privilege revoked. Data on drivers in fatal crashes show some increase in HBD rates for 1979 when they could no longer drink legally. However, the HBD rates in the 20% sample for these cohorts both show decreases in 1979.

The pattern for older cohorts is reversed. Most show some decrease in HBD rate for drivers in fatal crashes in 1979, while an increase in HBD rate among drivers in the 20% sample is noted. This is consistent with the finding for ages in general. It appears that raising the legal drinking age may have reduced the HBD rate for young drivers in the 20% sample, but that no similar reduction was observed among young drivers involved in fatal crashes.

2.4 Summary of Accident Data Analyses

Both the 20% sample and the fatal data show that the HBD rate among 18- to 20-year-old drivers increased markedly with the reduction of the legal drinking age in 1972. This is consistent with the results reported earlier [1] and with other findings [2-5]. Further, each cohort of drivers showed a consistent pattern of its HBD rate increasing substantially the year that that cohort could first drink legally. Again, this pattern was consistent in all crashes

(20% sample) and specifically in the fatal data. This shows that legal enfranchisement is associated with an increase in the HBD rate, and that lowering the legal drinking age increased the HBD rate for younger drivers, while having little or no effect on the rate for older drivers.

Turning to the more recent law change that raised the legal drinking age to 21, a mixed pattern of responses was observed. In the set of all accidents (20% sample), this was associated with a large and statistically significant reduction in the HBD rate for ages 18-20. This is particularly persuasive in view of the fact that older ages showed statistically significant increases in their rates in 1979. In the cohort data, two cohorts of drivers had their legal drinking privileges interrupted by the law change. Both of these groups showed decreases in their HBD rates in 1979. One of these was not quite significant ($X^2=4.19$) while the other was just significant ($X^2=6.93$) at the cohort-wise 5% level. The data from all accidents thus support the conclusion that the increased legal drinking age reduced the HBD rate.

The fatal data show a different pattern of response. Among specific age groups, there were no significant changes in HBD rates corresponding to raising the legal drinking age. The HBD rate in fatals for all drivers did increase significantly. Among drivers directly affected by the law change, only the 18-year-old drivers showed a decrease in their HBD rate, while 19- and 20-year-old drivers showed an increase. Both the cohorts who had their legal drinking privileges interrupted showed HBD rates that continued to increase even when they could no longer drink legally. Thus no effect of the law change was apparent from the HBD <u>rates</u> for drivers involved in fatal accidents. However, the <u>frequency</u> of HBD involvements decreased 10.5% in 1979 for the 18-20 group compared to a 12.1% increase for all other ages combined. Overall, the fatal

frequency data are consistent with reduced alcohol-related crashes resulting from the law change, but the indications are in the form of trends rather than established and statistically significant patterns.

We have formulated an hypothesis that may explain the difference in results between the HBD rates for all drivers and those for drivers involved in fatal accidents. Higher blood alcohol concentrations have been associated with problem drinkers more so than with occasional drinkers in many different studies. It is also well established that these higher concentrations are also strongly associated with more severe crashes. Presumably the serious problem drinker, even if young, would be relatively little affected by a law raising the legal drinking age. It may be that a high proportion of drivers involved in fatal crashes are problem drinkers and so less responsive to the law change. If true, this would mean that the seven years of lower legal drinking age (1972-1978) in Michigan led to development of problem drinkers at a somewhat earlier age. Further, one would expect that a longer period of time than just the one year (1979) would be needed before (indeed, <u>if</u>) the law change will affect the HBD rates among the drivers in fatal accidents. We emphasize that this line of reasoning is hypothetical and needs testing in future research.

3. ANALYSIS OF BREATHALYZER TEST REPORTS

Michigan's breath-testing program began in the fall of 1967 as a result of the "implied consent" legislation.[1] This legislation provided that motorists were deemed to have given their consent to a chemical test of blood, breath, urine, or other bodily substance for the purpose of determining blood alcohol content if they had been arrested for driving under the influence or driving while impaired by intoxicating liquor. The legislation also provided that a motorist had the option of refusing a test altogether or demanding that only a breath test be given.

As a result of this legislation, and with financial support from the U.S. Department of Transportation, an extensive network of Breathalyzer (Reg. trademark) test instruments was established throughout the state by the Michigan Department of State Police. The Safety and Traffic Division (now the Traffic Services Division) of the Department also formalized the procedures for conducting breath tests and for recording their results through use of a BREATHALYZER TEST REPORT (BTR). The latest revision of this form (UD 31, Rev. 6-78) is shown in Appendix B.

Until recently, standard operating procedures called for the completion of a BTR, in duplicate, each time a breath test was given. Occasionally, however, a BTR was filled out in the past even if a drunk-driving defendant refused to take a breath test. This could happen, for example, if the defendant refused to take the breath test after the testing officer had prepared and calibrated

---

[1] PA 253, State of Michigan, 74th Legislature, Regular Session of 1967, Enrolled House Bill No. 2038.

his instrument. The BTR in this case might then be annotated with the fact of the refusal and the form mingled with the test forms for which the test was offered and accepted.[1]

The Michigan Department of State Police and the City of Detroit Police Department also use ALCOHOLIC INFLUENCE REPORT forms (AIR's) with drunk-driving arrests. These forms, although not the same for the two departments, contain much of the same information as the BTR's and additional information about the arrest as well. The AIR's are sometimes used alone and sometimes in conjunction with a BTR.

A copy of the BTR--usually xerographic or carbon, but occasionally filled in by hand--and the AIR, if applicable, is subsequently forwarded to the Traffic Services Division of the Department of State Police. For 1979 and earlier years, the BTR's were tabulated and the data compiled into various reports and used for administration of the breath-test program. (Starting in 1980, a revised version of the BREATHALYZER TEST LOG [Form UD-33] was used to record breath-test results. The logs--one for each instrument throughout the state--are collected monthly by the Traffic Services Division for administrative and statistical purposes.)

The BTR's and AIR's, after processing by the Traffic Services Division, were subsequently forwarded to the Michigan Department of State for its use in license appeal hearings. The forms were made available to HSRI for data processing in the present research program by MDOS.

---

[1] The refusal information recorded on the BTR has no official standing. A different form--Officer's Sworn Report of Refusal to Submit to Chemical Test (D193)--is forwarded to the Driver Improvement Division, Michigan Department of State, and forms the basis for official administrative sanctions against the refuser's driving license.

3.1 Overview of BTR Data

In all, 65,576 DUIL/DWI arrests were identified from the BTR's and AIR's that were processed. As discussed more fully later, these arrests were incurred by 61,417 individuals, with the difference of the two (4159) accounted for by two or more arrests of the same persons.

Of the total arrests in the digital file, 30,649 occurred during 1978 and 34,311 occurred during 1979. The balance--616 cases--either occurred in earlier years or had missing data on this item.

These drunk-driving arrests are overwhelmingly a male phenomenon, with 92% of them incurred by males. Females represented 7.6% of 1978 arrestees and 8.5% of 1979 arrestees.

The average age of the arrestees is 33 years. About 2.2% are 17 years or younger, 51% are 30 years or younger, and 75% are 42 years or younger. About 1.7% of the defendants are 65 years or older. Issues related to age are discussed more fully in Section 3.2 dealing with the increase of Michigan's legal drinking age from 18 to 21 in late 1978.

Michigan residents accounted for 96.2% of the arrests. The neighboring jurisdictions of Illinois, Indiana, Ohio, Ontario, and Wisconsin together accounted for 2.5%, with the rest scattered among 51 other states and provinces.

The county in which the arrest occurred was determinable for 94% of the cases. Of these, 52.8% took place in Macomb, Oakland, and Wayne counties. The next 13 most frequent counties (Bay, Berrien, Genesee, Ingham, Jackson, Kalamazoo, Kent, Livingston, Monroe, Ottawa, Saginaw, St. Clair, and Washtenaw), each with from 1%-4% of the total, together accounted for 26.7% of the arrests for which the location was determinable.

Information about the pre-arrest event which triggered the DUIL arrest is available. The form provides boxes for checking whether an accident led to the arrest or some driving violation--speeding, for example, would be a legitimate reason for stopping a vehicle, although the specific fact of speeding would not be noted on the BTR--preceded the arrest. An accident was checked as the triggering event in 17% of the cases, a driving violation (without an accident) was checked in 79.9% of the arrests, and both boxes were checked on 1.3% of the BTR's.

The BTR form also provides for recording the kind of offense for which the breath test is given. The DUIL offense accounted for 98.5% of the arrests with DWI (Driving While Impaired) noted for only 0.2%. Drunk & Disorderly, Drunk Motor Law, other charges, and missing data account for the remainder.

The type of arresting department was determinable from the BTR in 93% of the cases. Of these, the Michigan Department of State Police made 24% of the arrests, county sheriff departments made 15%, city police departments 54%, and other agencies, primarily township police departments, accounted for 7%. Additionally, the Department of Natural Resources used the breath test 45 times (0.07%), and there were 24 miscellaneous users, such as prisons checking the blood alcohol content of returning parolees.

3.2 Effect of the Increased Legal Drinking Age

In the Introduction it was noted that Michigan raised its minimum legal drinking age from 18 to 21, effective December 13, 1978. These DUIL data for 1978 and 1979, therefore, present an attractive alternative to the use of accident data only for assessing the effect of the increased legal drinking age. In the following analysis the data have been treated as if the change in legal drinking age were effective January 1, 1979. The effect is minor, of

course, but it should be noted that the real differences in the DUIL arrest patterns of the 18- to 20-year-old drivers would be slightly greater than the differences reported here.

3.2.1 Changes in DUIL Arrests: Age and Year Effects

The data to be presented in this section are highly persuasive that the increased legal drinking age definitely reduced the amount of drunk driving among the affected age group. It will be shown that the number of DUIL arrests, as measured by the BTR's, actually increased for all other ages from 1978 to 1979 but in fact decreased for the 18-20 age group. (The reason for part of the overall increase is discussed in Section 3.3.)

Table 17 presents the 1978 and 1979 frequencies for DUIL arrests for which a valid breath test was obtained. While drivers in all other age groups experienced a 20% increase in drunk-driving arrests from 1978 to 1979, drivers aged 18-20 experienced a 7% decrease during the same period.

Table 17

DUIL Arrests by Year
18-20 vs. All Others

Age	Year		Yearly Change
	1978	1979	
18-20 . .	4,049	3,757	-7.2%
All others	23,302	28,058	+20.4%
TOTAL . .	27,351	31,815	+16.3%

Examination of the 3-year age groups adjacent to the affected age group is also useful. Table 18 presents, from the same dataset, DUIL arrests for the five 3-year groups from 15-29. Each of the other fourteen 3-year age groups from 30-71 exhibits the same pattern as drivers aged 15-17 and 21-29: The 1979 DUIL arrests always exceed those for 1978.

Table 18

DUIL Arrests by Year
3-year Age Groups

Age	Year		Yearly Change
	1978	1979	
15-17	646	695	+7.6%
18-20	4,049	3,757	-7.2%
21-23	3,769	4,590	+21.8%
24-26	2,825	3,653	+29.3%
27-29	2,227	2,896	+30.0%

Table 19 provides the same information for the fifteen single years from age 15-29. Here again it is seen that the 18-, 19-, and 20-year-old drivers had fewer DUIL arrests in 1979 than in 1978, and that all of the other single-year groups had more arrests in 1979 than in 1978. The increases range from 6.7% for the 17-year-olds to 42.0% for the 25-year-olds. Table 19 also shows that the highest frequency of any of the single-year groups during 1978 occurred for the 20-year-old drivers (1455 arrests). The peak shifted to the 21-year-old drivers in 1979, with 1624 arrests for these drivers; the 22-year-old drivers had about the same number and percentage increase over 1978 as the 21-year-old-drivers.

Table 19

DUIL Arrests by Year
Single Years from 15 to 29

Age	Year		Yearly Change
	1978	1979	
15	4	5	+25%
16	122	135	+10.7%
17	520	555	+6.7%
18	1192	1131	-5.1%
19	1402	1259	-10.2%
20	1455	1367	-6.0%
21	1280	1624	+26.9%
22	1306	1612	+23.4%
23	1183	1354	+14.5%
24	1050	1331	+26.8%
25	873	1240	+42.0%
26	902	1082	+20.0%
27	805	1029	+27.8%
28	755	960	+27.2%
29	667	907	+36.0%

3.2.2 Investigation of Two Alternative Explanations

The data presented above indicate strongly that the number of drunk drivers among 18- to 20-year-old drivers decreased from 1978 to 1979. The reduced legal drinking age is the most plausible reason for the observed reduction. Indeed, the authors do not know of any other social changes, changes in the traffic system, or changes in arrest procedures or the associated data, that would result in fewer DUIL arrests among 18-,19-, and 20-year-old drivers while at the same time resulting in more DUIL arrests among other drivers. Nonetheless, it is certainly prudent to acknowledge the possibility that the observed reductions among the 18-20 age group might result from other changes in the system.

One potential explanation of the differential arrest experience for the 18-20 age group might be found in the willingness to accept a breath test. As noted earlier, a DUIL defendant is legally entitled to refuse to take a breath test. The fact of the refusal is recorded and sworn to by the arresting officer, and the form is forwarded to the Department of State. The Department notifies the DUIL defendant that it has received official notice of refusal to take a chemical test and informs the defendant of his right to a License Appeal Board hearing regarding the arrest procedures. A second-level appeal through the courts is also possible if the defendant does not accept the LAB's conclusion. If the defendant does not appeal, or if neither of the appeals is successful, then the refusal information is recorded on the defendant's master driving record and his license is suspended or revoked. A very much higher proportion of 18- to 20-year-old DUIL arrestees refusing to take a breath test in 1979 compared to 1978 conceivably could account for the data and findings presented earlier.

In order to investigate this possibility, information about the refusals processed by the Department of State was obtained. Table 20 presents the number of drivers, by age, for whom a Chemical Test Refusal was recorded in 1978 [10] and in 1979.[1] The number of refusals, as contrasted with the number of drivers refusing, is some 2-3% higher because of two or more refusals by a small percentage of these drivers.

It is seen that in 1979 there were 89 more 18- to 20-year-old drivers having a Chemical Test Refusal recorded on their driver license than in 1978, a 21% increase. Every other age group also experienced an increase, however. The increases are seen to be proportionately larger as well, except for the

---

[1] Personal communication April 10, 1981 with J. VanLiew, Administrative Analyst, Michigan Department of State.

Table 20

Drivers with Chemical Test Refusals - 1978 and 1979

Year	Age Groups							TOTAL
	<18	18-20	21-23	24-39	40-59	60-75	>75	
1978	42	424	667	3146	1875	202	1	6357
%	.66	6.67	10.49	49.49	29.50	3.18	.02	100.0
1979	68	513	966	4383	2364	243	5	8542
%	.80	6.01	11.31	51.31	27.68	2.84	.06	100.0
Percent change 1978-1979 .	+61.9	+21.0	+44.8	+39.3	+26.1	+20.3	--	+34.4

60-75 group. The result is that the 18-20 group contained 6.67% of the drivers in 1978 but only 6.01% in 1979. Thus our conjecture that a higher refusal rate in 1979 compared to 1978 accounted for the reduced number of 18- to 20-year-old DUIL drivers noted in 1979 is not substantiated.

We are now in a position to combine the data for the arrested and tested drivers with those who were arrested but refused a chemical test. The combined data are given in Table 21. This table shows the total number of drivers who were arrested for DUIL in 1978 and 1979, and who either accepted a test or refused a test and did not successfully appeal. The format is the same as Tables 17-19 except for the age groupings; these are dictated by the age ranges chosen by the Department of State for their tables. The earlier tables, however, present the number of arrests experienced by drivers in various age groups, whereas Table 21 gives the number of drivers who have had one or more arrests.

Table 21

Total DUIL Drivers - 1978 and 1979

Age	Year		Yearly Change
	1978	1979	
<18 .	681	745	+9.4%
18-20	4,334	3,973	-8.3%
21-23	4,309	5,149	+19.5%
24-39	13,362	16,815	+25.8%
40-59	8,756	9,535	+8.9%
60-75	1,267	1,382	+9.9%
>75 .	19	42	+121.1%
TOTAL	32,728	37,651	+15.0%

As expected, the same pattern is evident for the drivers, now including those who refused to take a breath test, as was evident for the arrests. All other age groups experienced an increase, ranging from 8.9% for the 40-59 age group to 25.8% for the 24-39 group, while at the same time a decrease of 8.3% occurred for drivers aged 18-20. From these data it is now clear that a markedly higher refusal rate in 1978 than in 1979 among the 18-20 group did not account for the lower arrest experience in 1979 that has been identified.

Another potential explanation of the differential DUIL arrest experience for the 18-20 group--although far more speculative--is that police officers have not dealt consistently with this group over the past few years. An inconsistency might have existed in either of two forms.

One possibility is that police officers were relatively more lenient with 18- to 20-year-old drunk drivers in 1979 than in 1978 because that group had just lost its legal drinking privileges. Such a practice might have reflected a general feeling among police officers that the legal drinking age should not

have been increased for this group of young adults. Another possibility is that officers were more zealous with this group in the 1972-1978 period because they felt that 18- to 20-year-old drivers should not have been permitted to drink legally starting in 1972, and they were making a special effort to get that message across. If such were the case, then the increase in legal drinking age to 21 in late December, 1978, might have then been followed by a more relaxed attitude on their part starting in 1979.

Either of these possibilities would suggest, if true, that some officers might arrest only the very drunk drivers and would not charge marginally drunk 18- to 20-year-old drivers during 1979. Under this assumption, there might be some shift, from 1978 to 1979, in the BAC distribution for the affected age group. It would be further speculated that the shift would cause the average BAC of 1979 arrestees to be higher than the average for 1978. A higher percentage of arrested drivers would also be found in the higher BAC ranges.

The first of these possible changes was not observed in this dataset. The average BAC for the 18-20 age group in 1978 was 0.1578% W/V. For 1979 the average BAC was 0.1573% W/V, an insignificant change.

The second possible change--a shift of drivers from lower to higher BAC ranges--can be examined in Table 22. It gives the distribution of the arrested and tested 18- to 20-year-old drivers for the two years in terms of the legally presumptive limits relevant to drunk-driving arrests. (Drivers testing at or below 0.07% W/V are presumed to be not under the influence, drivers testing 0.08 or 0.09 are presumed to be Driving While Impaired, and drivers at a BAC of 0.10 or higher are presumed to be Driving Under the Influence of Liquor. The 0.15 BAC is of historical interest in that formerly it was the presumptive limit for DUIL.)

Table 22

Distribution of 18- to 20-year-old DUIL Arrestees
by
Year and BAC's

Year	BAC Range				TOTAL
	0 - 0.07	0.08 - 0.09	0.10 - 0.14	0.15 - 0.33	
1978	278 6.9%	209 5.2%	1347 33.3%	2215 54.7%	4049 100.0%
1979	235 6.3%	218 5.8%	1244 33.1%	2060 54.8%	3757 100.0%

The table shows that there have been minimal shifts in the distribution of arrests by BAC from 1978 to 1979. The percentage of all arrests for this age group in the lowest range has decreased slightly from 6.9% in 1978 to 6.3% in 1979, but this is exactly offset by the 0.6% increase in the 0.08 - 0.09 range.

There are no obvious changes, from the pre-law period to the post-law period, in DUIL arrest practices for the 18-20 group that can be inferred from this line of inquiry. No evidence of police favoritism or prejudice is apparent from this dataset.

This section has presented, in considerable detail, the DUIL arrest patterns for drivers of all ages during 1978 and 1979. The 18-, 19-, and 20-year-old drivers, whether considered singly or as a group, consistently show fewer arrests in 1979 than in 1978. Drivers of all other ages, specifically including those just slightly younger and older, experienced more arrests in 1979 than in 1978. Neither of the other two possible explanations that were investigated was found to have merit. The only reasonable explanation

consistent with these data is that the increased legal drinking age led to an immediate and substantial decrease in the number of 18- to 20-year-olds driving unsafely while under the influence of liquor.

3.3 Effect of Warrantless Arrest at Accident Scenes

Prior to August, 1978 the motor vehicle and criminal codes did not specifically provide for DUIL arrests of drunk drivers at accident scenes. The applicable sections of these codes were amended in 1978 (P.A. 1978, No. 384 and No. 391) to enable officers to arrest drunk drivers at accident scenes without a warrant. The perceived gap in the arrest powers of officers for handling accident-involved drunk drivers is indicated in the legislative analysis of one of the bills:[1]

> Although under present law police officers are authorized to make warrantless arrests for felonies which they have not personally witnessed, a person who commits a misdemeanor offense, including "driving under the influence of liquor", cannot be arrested without a warrant unless the offense was committed in the presence of a police officer. In the majority of automobile accidents involving intoxicated drivers, a police officer does not actually witness the accident and therefore cannot arrest the driver and conduct a breathalyzer test under "implied consent" provisions of drivers' license issuance. Some persons believe that this is a serious flaw in the law which should be corrected to allow an officer to make an arrest if the officer has good reasons to believe that a person at the scene of an accident has been driving under the influence of liquor.

Also pertinent, among the arguments advanced for the bill, is the relationship to arrest for public intoxication:

> Public intoxication became decriminalized on January 15, 1978. As a result, an officer cannot arrest a drunken driver on a charge of "public intoxication" at the scene of an accident. Without House Bill 4492, police officers would have their hands completely tied at the scene of an accident involving a drunk driver.

Accordingly, the Michigan code of criminal procedure was revised to include the following, and the same language was inserted into the motor vehicle code:

---

[1] ANALYSIS - H.B. 4642 (2-13-78), House Legislative Analysis Section.

Sec. 15 (1) A peace officer may, without a warrant, arrest a person in the following situations:

(h) When the peace officer has reasonable cause to believe that the person was, at the time of an accident, the driver of a motor vehicle involved in the accident and was driving the vehicle upon a public highway of this state while under the influence of intoxicating liquor.

This revision of the criminal code was effective July 27, 1978 and the associated motor vehicle code revision was effective August 1, 1978.

Breathalyzer test reports show whether the DUIL arrest was preceded by an accident, a driving violation, or both. The dataset covers 7 months before the law changed and 17 months after, and thus it lends itself to an examination of whether the warrantless arrest provision is fulfilling its intended purpose.

3.3.1 Changes in Preceding Incident Patterns

A sharp change in the pattern of preceding incidents, starting exactly in August, 1978, is seen from Table 23. The table gives, for the DUIL cases for which both a breath test was given and the preceding incident was identified, the arrests by month for 1978.

Starting in August, the frequency of DUIL arrests preceded by an accident just about doubled, increasing each month thereafter (excepting November), and peaked at 646 in December. The monthly percentage attributable to these cases averaged 8.5% in the first 7 months, with a low of 7.0% in April and a high of 9.3% in July. The percentage jumped to 16.9% in August and continued to increase each month thereafter (again except for November), reaching 21.6% in December. The 5-month, August-December average of 19.0% is more than double the comparable percentage in the 7-month, pre-law period.

Table 23

1978 DUIL Arrests by Month and Preceding Incident

Month	Preceding Incident			TOTAL
	Accident	Violation	Both	
January	124 8.6%	1291 89.9%	21 1.5%	1436 100%
February	145 8.4%	1564 90.6%	18 1.0%	1727 100%
March	205 8.4%	2214 90.4%	30 1.2%	2449 100%
April	170 7.0%	2214 91.6%	34 1.4%	2418 100%
May	175 9.1%	1720 89.5%	26 1.4%	1921 100%
June	163 8.7%	1682 90.1%	22 1.2%	1867 100%
July	193 9.3%	1867 89.5%	25 1.2%	2085 100%
JANUARY - JULY SUBTOTALS	1175 8.5%	12,552 90.3%	176 1.3%	13,903 100%
August	371 16.9%	1793 81.5%	37 1.7%	2201 100%
September	450 17.5%	2079 81.0%	39 1.5%	2568 100%
October	536 19.2%	2224 79.5%	36 1.3%	2796 100%
November	484 19.0%	2021 79.4%	41 1.6%	2546 100%
December	646 21.6%	2296 76.8%	46 1.5%	2988 100%
AUGUST - DECEMBER SUBTOTALS	2487 19.0%	10,413 79.5%	199 1.5%	13,099 100%

Table 24 shows the same data for the first 7 months of 1978 compared to the first 7 months of 1979. The frequency of arrests preceded by an accident increased 177.4% from 1978 to 1979, nearly triple. Arrests preceded by violations were up only 14.7% in the same period. The post-law period shows 18.2% of all arrests triggered by a preceding accident compared to 8.5% in the pre-law period.

Table 24

DUIL Arrests by Month and Preceding Incident
January - August

Month	Preceding Incident			TOTAL
	Accident	Violation	Both	
January-July, 1978	1175 8.5%	12,552 90.3%	176 1.3%	13,903 100%
January-July, 1979	3259 18.2%	14,393 80.5%	227 1.3%	17,879 100%
Frequency change .	+2084	+1841	+51	+3976
Percentage change in frequencies . .	+177.4%	+14.7%	+29.0%	+28.6%

Data from these two tables speak for themselves. The frequency of arrests preceded by accidents sharply increased in August, 1978, exactly when the warrantless arrest provision went into effect. The percentage of DUIL arrests accounted for by this category doubled at the same time, and both of these shifts were sustained during the following months. Looking at the accident data during the same general time period, we find that the number of Had Been Drinking accidents and the number of HBD, accident-involved drivers actually

decreased about 1% from 1978 to 1979.[1] Therefore the increased number of DUIL arrests triggered by an accident must have come, not from increased numbers of alcohol-related accidents, but from the way police were arresting drivers involved in those accidents. Clearly the warrantless arrest provision of the criminal and motor vehicle codes is serving its intended purpose.

---

[1] Had Been Drinking accidents numbered 58,636 in 1978 and 58,127 in 1979. HBD drivers numbered 61,723 and 60,834 for these years. Source: Michigan Traffic Accident Facts, 1978 and 1979, Michigan Department of State Police.

4. DUIL ENFORCEMENT INDEX

At the beginning of the project a DUIL enforcement index was conceived as an aid to further our understanding of the alcohol-related crash problem and law enforcement efforts to deal with it. It was also thought that the index would assist policy makers and program planners in their efforts to plan countermeasure efforts and to allocate limited resources to competing traffic safety projects.

This section presents the exploratory work that has been completed. Derivation of the index is given and the raw data for the state, for each of Michigan's 83 counties, and for the 56 cities with population of 20,000 or more are provided.

4.1 Derivation of the Index

The DUIL enforcement index is the ratio of a jurisdiction's DUIL arrest frequency, for some given time period, to its alcohol-related crash frequency during the same period. DUIL arrests, as used here and in the preceding sections as well, include those for which the offense noted on the Breathalyzer Test Report is a DUIL (Driving Under the Influence of Liquor), DWI (Driving While Impaired), or DML (Drunk Motor Law). Alcohol-related crash frequencies are obtained from the HBD (Had Been Drinking) variable recorded on the UD-10 Accident Report form.

DUIL arrests with valid breath tests were determined for each county and for 56 cities (identified later) from the BTR file detailed in the preceding section. Counts of HBD accidents were determined for each of the jurisdictions using HSRI's ADAAS software package on accident report data supplied by the Department of State Police.

4.2 County Data

Table 25 contains the arrest and accident frequencies for the 83 counties for 1978 and 1979. The entire state experience appears in the form of an "84th county," identified as "MICH84" in this and subsequent tables. The difference between "Total" and the sum of the "HBD"+"HNBD" frequencies represents missing data on this variable.

Table 26 contains six different quotients derived from data in the previous table. For each of these the rank for each of the 84 entries is also given, with the lowest rank assigned to the highest ratio.

Column 2 gives the 1979 HBD frequencies divided by the 1978 HBD frequencies. From this column it can be seem that the entire state experienced about a 1% drop in HBD accidents from 1978 to 1979. Leelanau County (rank 1) had 39.5% more HBD accidents in 1979 than in 1978, while Schoolcraft County (rank 84) had 25% fewer in 1979 than in 1978.

Figure 2 shows the 83 counties and is included to more easily interpret the subsequent figures. Figure 3 summarizes the data of column 2. The shading has been constructed so that counties with a 10% year-to-year variation--either plus or minus--are unshaded. The largest increases, as indicated in the legend, have the darkest (finest) shading, while counties with the largest decreases, have the sparsest shading. The majority of the counties have less than a 10% yearly change. Three of the counties have a 20% or greater increase from 1978 to 1979, while four counties have 20% or greater reduction. Readers familiar with Michigan will recognize that the larger year-to-year variations, whether up or down, are generally associated with counties having smaller populations and fewer accidents. These counties are more likely to have larger percentage changes due to chance variations alone.

Table 25

1978 and 1979 Accident and DUIL Frequencies by County

County	1978				1979			
	Arrests	Accidents			Arrests	Accidents		
		HBD	HNBD	Total		HBD	HNBD	Total
Alconl	12	70	321	406	8	77	256	342
Alger2	13	104	287	400	12	91	256	358
Alleg3	222	506	2250	2832	235	449	2062	2596
Alpen4	89	254	847	1146	101	264	798	1087
Antri5	63	101	503	611	53	86	498	592
Arena6	33	160	604	774	43	121	478	618
Barag7	17	82	270	370	23	79	256	359
Barry8	84	225	1365	1627	87	249	1382	1678
Bay9 .	236	939	4104	5206	445	1003	3725	4902
Benz10	4	84	394	495	7	102	363	482
Berrn1	822	1209	6578	8155	970	1031	5878	7279
Brnc12	205	247	1514	1816	224	229	1364	1644
Calhn3	288	909	5504	6709	251	859	5088	6219
Cass14	217	387	1734	2173	234	366	1454	1910
Chrlx5	41	144	622	779	42	141	663	812
Chbyn6	51	151	598	771	14	153	610	791
Chipl7	59	275	854	1203	77	208	884	1165
Clar18	74	223	1072	1320	95	182	925	1148
Clntn9	210	329	1663	2032	244	329	1534	1914
Craw20	63	88	478	590	60	86	398	504
Delt21	35	286	1439	1817	62	285	1365	1722
Dick22	47	196	816	1058	82	185	909	1134
Eaton3	141	496	2547	3114	128	462	2350	2877
Emmet4	48	174	862	1073	102	193	906	1149
Gene25	941	3142	13663	17556	1533	3211	12327	16212
Glad26	118	110	616	744	122	115	513	638
Goge27	54	154	620	814	35	150	546	741
GTrav8	77	464	2558	3094	73	411	2419	2894
Grat29	63	240	1361	1667	129	234	1283	1597
Hil130	79	250	1481	1847	46	241	1274	1615
Hghtn1	94	286	1053	1420	225	274	1058	1418
Huron2	186	245	1003	1286	165	220	876	1126
Ingh33	834	1706	11091	12955	870	1648	9786	11600
Ionia4	50	355	1690	2127	96	375	1837	2317
Iosc35	68	238	1083	1340	133	239	890	1155
Iron36	35	91	397	516	66	93	422	550
Isab37	44	320	1661	2019	50	295	1529	1857
Jack38	329	1123	5698	7126	374	1045	5243	6573
Kzoo39	597	1204	8518	10135	817	1201	8121	9809
Kalk40	102	94	442	548	69	71	404	480
Kent41	786	2526	18371	21448	895	2703	18713	22510
Kwnw42	10	34	38	74	12	36	47	86

Table 25 - Continued
1978 and 1979 Accident and DUIL Frequencies by County

County	1978				1979			
	Arrests	Accidents			Arrests	Accidents		
		HBD	HNBD	Total		HBD	HNBD	Total
Lake43	11	88	358	450	24	86	300	392
Laper4	295	429	2073	2556	237	394	1960	2404
Lee145	26	76	311	410	17	106	346	477
Lena46	143	535	3586	4298	203	519	2960	3622
Livtn7	186	583	2759	3440	520	591	2548	3218
Luce48	50	58	206	277	6	53	190	265
Mack49	38	108	371	495	23	92	442	556
Mcmb50	2460	3768	20290	25216	3044	3775	18482	23351
Mnstel	24	202	795	1055	69	187	765	1025
Marq52	116	702	2502	3431	84	633	2252	3124
Mason3	24	228	1176	1446	25	184	1057	1289
Mecos4	69	236	1419	1692	52	233	1600	1872
Menm55	60	221	1015	1311	73	207	963	1245
Mid156	77	493	2545	3056	94	433	2393	2847
Missa7	22	51	333	388	16	47	286	339
Monr58	417	1046	3894	5073	383	931	3146	4185
Monty9	125	289	1744	2074	111	274	1767	2091
Mntc60	9	50	326	385	21	47	288	338
Musk61	199	1008	5762	6912	284	1070	5519	6730
Newa62	109	257	1218	1510	146	249	1041	1331
Oakd63	3392	6226	33778	41390	3483	6282	32684	40328
Ocea64	36	146	612	781	17	145	542	710
Ogem65	76	142	715	866	98	151	669	841
Onto66	15	66	231	309	26	80	217	315
Osceo7	21	108	739	872	20	124	763	922
Oscod8	35	81	311	399	29	69	303	378
Otse69	101	111	569	699	52	98	556	676
Otta70	300	602	4536	5208	362	665	4675	5399
Prsql1	15	77	454	541	17	81	411	511
Rosc72	50	168	660	845	21	147	572	741
Sagi73	352	1526	9235	10927	469	1658	8452	10313
StC174	279	1030	4168	5519	404	914	3781	5035
StJos5	108	341	2137	2578	197	294	1637	2028
Sani76	162	233	1002	1277	136	225	968	1224
Scho77	12	96	333	453	5	72	259	341
Shia78	126	374	1819	2276	65	346	1702	2131
Tusc79	149	388	1439	1860	198	375	1418	1825
Vbrn80	178	434	1827	2362	315	417	1649	2148
Wash81	648	1466	8367	10120	752	1510	7485	9257
Wayn82	7784	14204	73789	100020	8542	14398	67496	92913
Wexf83	39	168	1019	1223	29	173	1030	1238
MICH84	25879	58636	308993	389193	29978	58127	287264	366435

Table 26
1978 and 1979 Accident Rates and Ratios by County

County	HBD79/HBD78	Rank	78HBD Rate	79HBD Rate	79Rate/78Rate	Rank	78-79 Rate	Rank	79Arsts/78Arsts	Rank
Alconl	1.100	8	.172	.225	1.306	1	.197	17	.667	73
Alger2	.875	72	.260	.254	.978	59	.257	2	.923	58
Alleg3	.887	68	.179	.173	.968	63	.176	36	1.059	48
Alpen4	1.039	18	.222	.243	1.096	18	.232	4	1.135	43
Antri5	.851	78	.165	.145	.879	81	.155	55	.841	64
Arena6	.756	82	.207	.196	.947	69	.202	14	1.303	28
Barag7	.963	46	.222	.220	.993	53	.221	5	1.353	23
Barry8	1.107	6	.138	.148	1.073	29	.143	69	1.036	51
Bay9 .	1.068	11	.180	.205	1.134	10	.192	23	1.886	11
Benz10	1.214	2	.170	.212	1.247	2	.190	25	1.750	15
Berrn1	.853	75	.148	.142	.955	66	.145	68	1.180	36
Brnc12	.927	57	.136	.139	1.024	42	.138	73	1.093	46
Calhn3	.945	51	.135	.138	1.019	44	.137	74	.872	63
Cass14	.946	50	.178	.192	1.076	28	.184	30	1.078	47
Chrlx5	.979	35	.185	.174	.939	73	.179	33	1.024	54
Chbyn6	1.013	25	.196	.193	.988	56	.195	20	.275	83
Chipl7	.756	81	.229	.179	.781	83	.204	12	1.305	27
Clar18	.816	79	.169	.159	.938	74	.164	45	1.284	30
Clntn9	1.000	29	.162	.172	1.062	33	.167	41	1.162	37
Craw20	.977	37	.149	.171	1.144	9	.159	51	.952	55
Delt21	.997	31	.157	.166	1.051	37	.161	48	1.771	13
Dick22	.944	52	.185	.163	.881	80	.174	37	1.745	16
Eaton3	.931	55	.159	.161	1.008	48	.160	50	.908	60
Emmet4	1.109	5	.162	.168	1.036	38	.165	43	2.125	6
Gene25	1.022	22	.179	.198	1.107	14	.188	28	1.629	18
Glad26	1.045	17	.148	.180	1.219	3	.163	47	1.034	52
Goge27	.974	39	.189	.202	1.070	31	.195	18	.648	75
GTrav8	.886	69	.150	.142	.947	70	.146	66	.948	57
Grat29	.975	38	.144	.147	1.018	45	.145	67	2.048	7
Hil130	.964	45	.135	.149	1.102	15	.142	70	.582	77
Hghtn1	.958	48	.201	.193	.959	64	.197	16	2.394	3
Huron2	.898	65	.191	.195	1.026	41	.193	22	.887	62
Ingh33	.966	43	.132	.142	1.079	27	.137	75	1.043	49
Ionia4	1.056	15	.167	.162	.970	62	.164	44	1.920	9
Iosc35	1.004	27	.178	.207	1.165	6	.191	24	1.956	8
Iron36	1.022	21	.176	.169	.959	65	.173	38	1.886	10
Isab37	.922	60	.158	.159	1.002	50	.159	52	1.136	42
Jack38	.931	56	.158	.159	1.009	47	.158	53	1.137	41
Kzoo39	.998	30	.119	.122	1.031	40	.121	82	1.369	22
Kalk40	.755	83	.172	.148	.862	82	.161	49	.676	72
Kent41	1.070	10	.118	.120	1.020	43	.119	84	1.139	40
Kwnw42	1.059	14	.459	.419	.911	76	.438	1	1.200	35
MICH84	.991	33	.151	.159	1.053	36	.155	57	1.158	39

Table 26 - Continued
1978 and 1979 Accident Rates and Ratios by County

County	HBD79/HBD78	Rank	78HBD Rate	79HBD Rate	79Rate/78Rate	Rank	78-79 Rate	Rank	79Arsts/78Arsts	Rank
Lake43	.977	36	.196	.219	1.122	12	.207	9	2.182	5
Laper4	.918	62	.168	.164	.976	60	.166	42	.803	67
Lee145	1.395	1	.185	.222	1.199	4	.205	10	.654	74
Lena46	.970	40	.124	.143	1.151	8	.133	79	1.420	21
Livtn7	1.014	23	.169	.184	1.084	24	.176	35	2.796	2
Luce48	.914	63	.209	.200	.955	67	.205	11	.120	84
Mack49	.852	76	.218	.165	.758	84	.190	26	.605	76
Mcmb50	1.002	28	.149	.162	1.082	25	.155	56	1.237	31
Mnstel	.926	58	.191	.182	.953	68	.187	29	2.875	1
Marq52	.902	64	.205	.203	.990	54	.204	13	.724	71
Mason3	.807	80	.158	.143	.905	77	.151	62	1.042	50
Mecos4	.987	34	.139	.124	.892	79	.132	80	.754	68
Menm55	.937	54	.169	.166	.986	57	.167	40	1.217	33
Mid156	.878	71	.161	.152	.943	71	.157	54	1.221	32
Missa7	.922	61	.131	.139	1.055	35	.135	77	.727	70
Monr58	.890	66	.206	.222	1.079	26	.214	6	.918	59
Monty9	.948	49	.139	.131	.940	72	.135	76	.888	61
Mntc60	.940	53	.130	.139	1.071	30	.134	78	2.333	4
Musk61	1.062	13	.146	.159	1.090	22	.152	60	1.427	20
Newa62	.969	41	.170	.187	1.099	16	.178	34	1.339	24
Oakd63	1.009	26	.150	.156	1.036	39	.153	59	1.027	53
Ocea64	.993	32	.187	.204	1.092	20	.195	19	.472	80
Ogem65	1.063	12	.164	.180	1.095	19	.172	39	1.289	29
Onto66	1.212	3	.214	.254	1.189	5	.234	3	1.733	17
Osceo7	1.148	4	.124	.134	1.086	23	.129	81	.952	56
Oscod8	.852	77	.203	.183	.899	78	.193	21	.829	66
Otse69	.883	70	.159	.145	.913	75	.152	61	.515	79
Otta70	1.105	7	.116	.123	1.066	32	.119	83	1.207	34
Prsql1	1.052	16	.142	.159	1.114	13	.150	63	1.133	44
Rosc72	.875	73	.199	.198	.998	51	.199	15	.420	81
Sagi73	1.087	9	.140	.161	1.151	7	.150	64	1.332	25
StC174	.887	67	.187	.182	.973	61	.184	31	1.448	19
StJos5	.862	74	.132	.145	1.096	17	.138	72	1.824	12
Sani76	.966	44	.182	.184	1.007	49	.183	32	.840	65
Scho77	.750	84	.212	.211	.996	52	.212	7	.417	82
Shia78	.925	59	.164	.162	.988	55	.163	46	.516	78
Tusc79	.966	42	.209	.205	.985	58	.207	8	1.329	26
Vbrn80	.961	47	.184	.194	1.057	34	.189	27	1.770	14
Wash81	1.030	19	.145	.163	1.126	11	.154	58	1.160	38
Wayn82	1.014	24	.142	.155	1.091	21	.148	65	1.097	45
Wexf83	1.030	20	.137	.140	1.017	46	.139	71	.744	69
MICH84	.991	33	.151	.159	1.053	36	.155	57	1.158	39

Figure 2 - Map of Michigan with County Outlines and Names

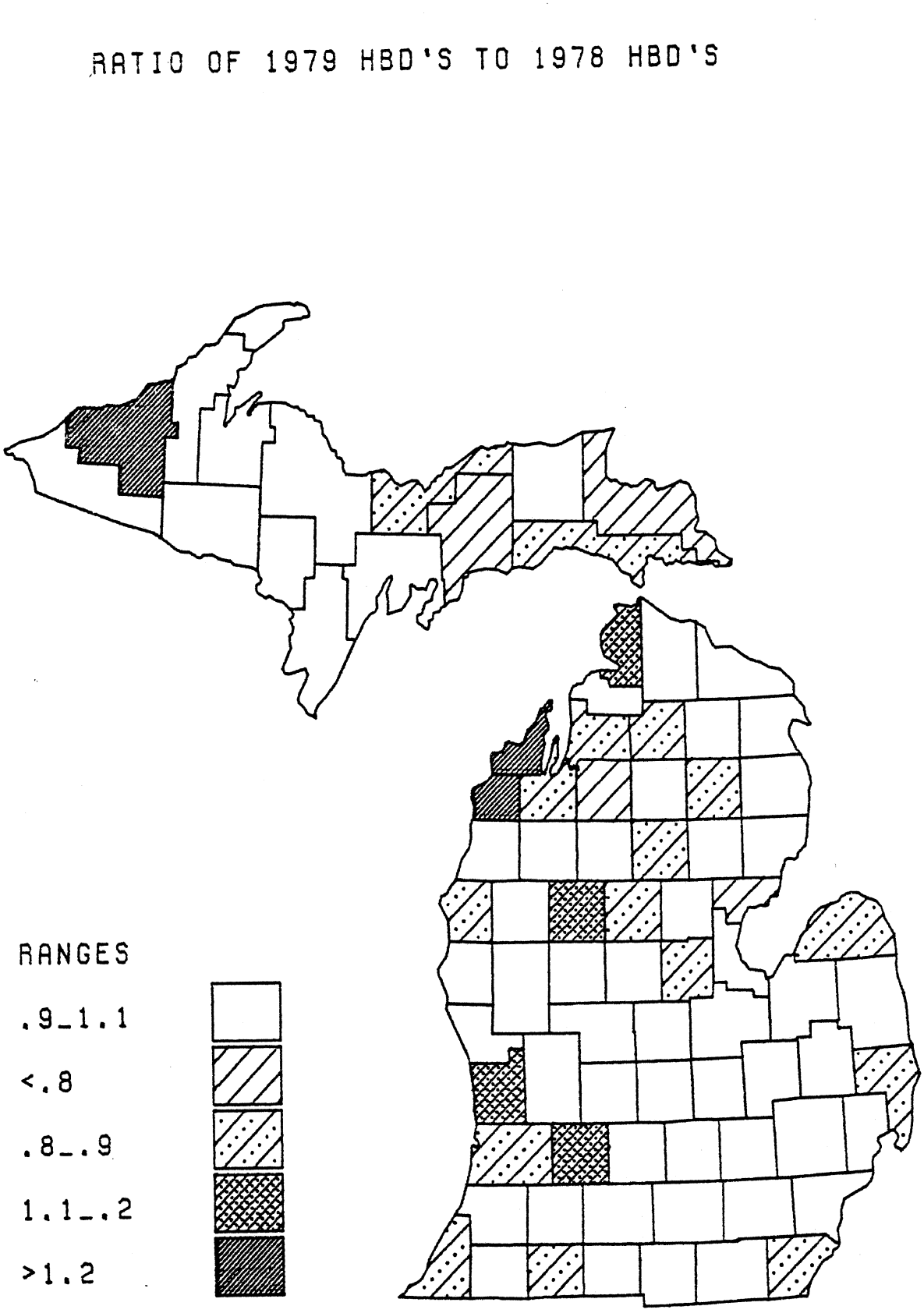

Figure 3 - Ratio of 1979 HBD's to 1978 HBD's

Columns 3 and 4 present the 1978 and 1979 HBD rates. In this section the HBD rate is given as the ratio of HBD accidents to the total number of accidents. The HBD rate for the entire state is seen to be 0.151 in 1978 and 0.159 in 1979, about a 5% increase. Column 6 gives the HBD rate for the two years combined, and Figure 4 summarizes the data in column 6. From these data it is apparent that there are wide differences in HBD rates throughout the state. Keweenaw County has by far the highest HBD rate in the state (0.438 for the two years combined), and its rate exceeds that of Alger County, the next highest (0.257) by some 70%. Clearly Keweenaw is unique, but we have no insight into the reasons why such is the case. It may be that the data accurately reflect an underlying phenomenon of much higher drunk driving there with a resulting high number of HBD accidents. Another possibility is that law enforcement officials serving Keweenaw County are particularly diligent in identifying alcohol involvement in crashes and recording their findings on the accident report. Another possibility is that the police agencies are lax in investigating and recording non-alcohol related crashes, thus producing an artificially low denominator, and an artificially high quotient, in the HBD rate calculation. We have no independent information with which to pursue any of these conjectures, but it would be worthwhile to investigate them further in subsequent research.

Kent and Ottawa Counties share the lowest HBD rate in the state, 0.119, about 23% lower than the state-wide average of 0.155. Again we have no definitive information that might explain the observed rates, but it is interesting to note that these two contiguous counties represent a generally more conservative part of the state. The conservatism is illustrated by the fact that they are two of the four counties that did not permit Sunday sales of liquor by the glass in 1978 or 1979. Whether the Sunday ban <u>per se</u>, or their

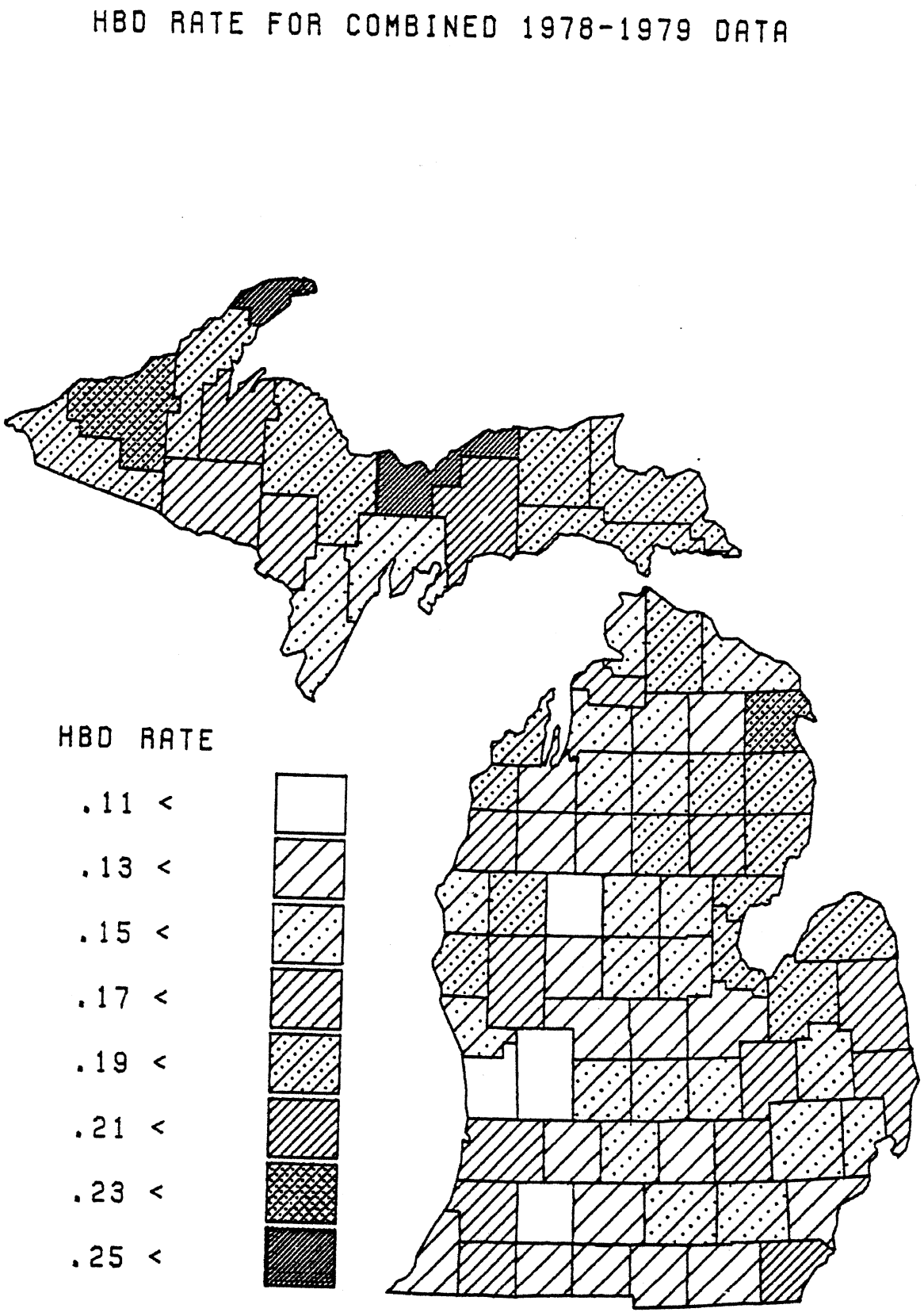

Figure 4 - HBD Rate for Combined 1978-1979 Data

generally more conservative nature, or other factors, lead to the low HBD rate is not known. Hillsdale and Missaukee Counties, the other two not permitting Sunday sales in 1978 or 1979, also had HBD rates below the statewide average. It will be interesting to observe Kent County's HDB experience in 1980, the first year that Sunday sales were permitted there.

Examination of Figure 4 does not reveal any dominant HBD patterns by county, but it does indicate some trends. The Upper Peninsula has relatively more of the counties with the higher HBD rates. Both of the counties (Alger and Keweenaw) with rates exceeding 0.25 are in the U.P., while none of the counties with rates in the lowest 0.11-0.13 range are there. Whether such differences are artifacts of police investigation and reporting practices, or of higher alcohol consumption and more drunk driving, or of other influences is not known. These are the kinds of differences which should be explored in future studies.

Table 27 presents the DUIL Enforcement Index for 1978 and for 1979, and gives the ratio of the 1979 index to that for 1978. The index for the two years combined is also given in the last column. Figure 5 depicts the rank of the counties by the index for the two years combined, with 5 groups of ten counties and 3 groups of eleven. The last column in the table shows that the state-wide average is 0.478. Benzie, Schoolcraft, and Mason counties have the lowest indexes, respectively 0.059, 0.101, and 0.119. Gladwin, Kalkaska, and Branch counties, at 1.067, 1.036, and 0.901, respectively, have the highest indexes.

The observations presented above are indicative of the kinds of insights and comparisons that can be made with various combinations of arrest and accident data. Clearly they are not at all exhaustive. Program planners contemplating the implementation of countermeasures generally, and alcohol-

Table 27
1978 and 1979 DUIL Enforcement Indexes by County

County	1978 Index	Rank	1979 Index	Rank	1979 Index / 1978 Index	Rank	1978-1979 Index	Rank
Alconl	.171	72	.104	81	.606	75	.136	80
Alger2	.125	79	.132	78	1.055	52	.128	81
Alleg3	.439	23	.523	30	1.193	38	.479	27
Alpen4	.350	35	.383	43	1.092	46	.367	40
Antri5	.624	13	.616	17	.988	57	.620	12
Arena6	.206	67	.355	47	1.723	17	.270	58
Barag7	.207	66	.291	56	1.404	24	.248	63
Barry8	.373	32	.349	49	.936	63	.361	41
Bay9 .	.251	59	.444	36	1.765	15	.351	43
Benz10	.048	84	.069	84	1.441	22	.059	84
Berrnl	.680	10	.941	4	1.384	26	.800	4
Brnc12	.830	5	.978	2	1.179	39	.901	3
Calhn3	.317	42	.292	55	.922	64	.305	52
Cassl4	.561	14	.639	16	1.140	42	.599	14
Chrlx5	.285	52	.298	54	1.046	53	.291	54
Chbyn6	.338	37	.092	82	.271	83	.214	68
Chipl7	.215	65	.370	44	1.725	16	.282	55
Clarl8	.332	39	.522	31	1.573	20	.417	34
Clntn9	.638	12	.742	10	1.162	41	.690	9
Craw20	.716	7	.698	12	.975	60	.707	8
Delt21	.122	81	.218	65	1.778	14	.170	77
Dick22	.240	61	.443	37	1.848	10	.339	44
Eaton3	.284	53	.277	59	.975	59	.281	57
Emmet4	.276	54	.528	27	1.916	9	.409	35
Gene25	.299	46	.477	34	1.594	19	.389	38
Glad26	1.073	2	1.061	1	.989	56	1.067	1
Goge27	.351	34	.233	63	.665	74	.293	53
GTrav8	.166	73	.178	70	1.070	50	.171	76
Grat29	.262	58	.551	24	2.100	7	.405	36
Hill30	.316	44	.191	68	.604	76	.255	62
Hghtnl	.329	40	.821	6	2.498	3	.570	19
Huron2	.759	6	.750	9	.988	58	.755	5
Ingh33	.489	20	.528	29	1.080	48	.508	23
Ionia4	.141	76	.256	61	1.818	13	.200	71
Iosc35	.286	51	.556	22	1.948	8	.421	32
Iron36	.385	30	.710	11	1.845	11	.549	21
Isab37	.137	77	.169	71	1.233	34	.153	78
Jack38	.293	49	.358	46	1.222	36	.324	46
Kzoo39	.496	19	.680	13	1.372	29	.588	16
Kalk40	1.085	1	.972	3	.896	65	1.036	2
Kent41	.311	45	.331	52	1.064	51	.321	47
Kwnw42	.294	48	.333	51	1.133	43	.314	48
MICH84	.441	22	.516	32	1.169	40	.478	28

Table 27 - Continued
1978 and 1979 DUIL Enforcement Indexes by County

County	1978 Index	Rank	1979 Index	Rank	1979 Index / 1978 Index	Rank	1978-1979 Index	Rank
Lake43	.125	80	.279	58	2.233	5	.201	70
Laper4	.688	9	.602	19	.875	66	.646	11
Lee145	.342	36	.160	74	.469	82	.236	65
Lena46	.267	57	.391	42	1.463	21	.328	45
Livtn7	.319	41	.880	5	2.758	2	.601	13
Luce48	.862	4	.113	80	.131	84	.505	24
Mack49	.352	33	.250	62	.711	73	.305	51
Mcmb50	.653	11	.806	7	1.235	33	.730	7
Mnstel	.119	82	.369	45	3.106	1	.239	64
Marq52	.165	74	.133	77	.803	69	.150	79
Mason3	.105	83	.136	76	1.291	32	.119	82
Mecos4	.292	50	.223	64	.763	71	.258	60
Menm55	.271	55	.353	48	1.299	31	.311	49
Midl56	.156	75	.217	66	1.390	25	.185	73
Missa7	.431	26	.340	50	.789	70	.388	39
Monr58	.399	29	.411	40	1.032	54	.405	37
Monty9	.433	24	.405	41	.937	62	.419	33
Mntc60	.180	71	.447	35	2.482	4	.309	50
Musk61	.197	68	.265	60	1.344	30	.232	66
Newa62	.424	27	.586	21	1.382	27	.504	25
Oakd63	.545	16	.554	23	1.018	55	.550	20
Ocea64	.247	60	.117	79	.475	81	.182	74
Ogem65	.535	17	.649	15	1.213	37	.594	15
Onto66	.227	64	.325	53	1.430	23	.281	56
Osceo7	.194	70	.161	73	.829	68	.177	75
Oscod8	.432	25	.420	39	.973	61	.427	31
Otse69	.910	3	.531	26	.583	77	.732	6
Otta70	.498	18	.544	25	1.092	45	.522	22
Prsql1	.195	69	.210	67	1.077	49	.203	69
Rosc72	.298	47	.143	75	.480	80	.225	67
Sagi73	.231	63	.283	57	1.226	35	.258	61
StCl74	.271	56	.442	38	1.632	18	.351	42
StJos5	.317	43	.670	14	2.116	6	.480	26
Sani76	.695	8	.604	18	.869	67	.651	10
Scho77	.125	78	.069	83	.556	79	.101	83
Shia78	.337	38	.188	69	.558	78	.265	59
Tusc79	.384	31	.528	28	1.375	28	.455	30
Vbrn80	.410	28	.755	8	1.842	12	.579	17
Wash81	.442	21	.498	33	1.127	44	.470	29
Wayn82	.548	15	.593	20	1.083	47	.571	18
Wexf83	.232	62	.168	72	.722	72	.199	72
MICH84	.441	22	.516	32	1.169	40	.478	28

RANK OF COUNTIES BY DUIL ENFORCEMENT INDEX

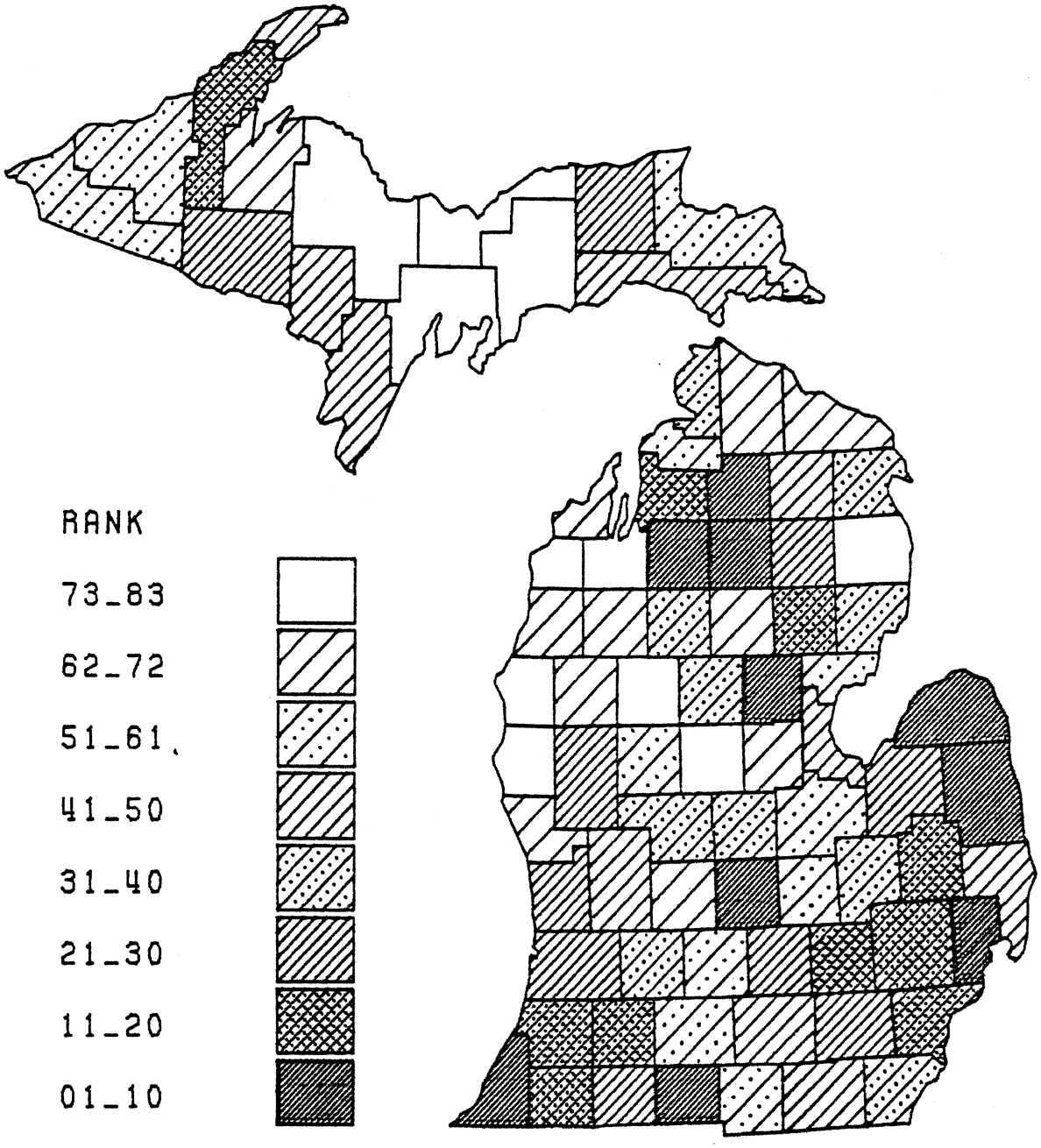

Figure 5 - Rank of Counties by DUIL Enforcement Index

related countermeasures specifically, should examine the jurisdictions under consideration in much greater detail. These data should prove useful both in allocating resources and in estimating the potential improvement upon implementation of countermeasures with varying degrees of effectiveness.

The effectiveness of countermeasures in reducing traffic accidents is an ongoing operational and research topic of the highest priority. In the present context we might well ask what is the effectiveness of DUIL enforcement activity in preventing alcohol-related accidents. This question can be addressed, at least on a global basis, by the data given above. The study in the future will undertake further research on this question.

4.3 City Data

The frequencies, rates, and ratios presented above for Michigan's counties have also been prepared for the 56 cities in Michigan with at least 20,000 population. These data are presented in Tables 28, 29, and 30 for reference purposes.

Table 28
1978 and 1979 Accident and DUIL Frequencies by City

City	1978				1979			
	Arrests	Accidents			Arrests	Accidents		
		HBD	HNBD	Total		HBD	HNBD	Total
Adrian	15	116	1107	1282	22	113	930	1101
AlnPrk	127	229	1165	1508	129	203	1149	1448
AnnArb	266	363	2530	2954	269	373	2276	2715
BatCrk	142	261	1876	2294	134	225	1668	2046
BayCty	54	291	1601	1951	86	303	1496	1895
Birmgh	34	105	919	1054	34	90	952	1076
Burton	99	217	881	1123	147	228	853	1097
Detrot	3015	7373	39579	55848	3183	7736	37062	52925
DrbnHt	115	420	2056	2773	167	359	1767	2359
Drborn	497	663	4511	5553	620	611	3872	4850
EDetrt	73	206	1063	1299	47	211	908	1209
ELansg	332	196	1199	1424	300	204	1087	1316
Ferndl	69	104	289	439	55	122	333	519
Flint	203	1484	6508	8567	559	1467	5760	7749
FrmHls	53	251	1483	1762	135	288	1609	1941
GrdnCt	274	233	1051	1370	278	227	965	1265
GrRpds	325	1075	9069	10455	479	1184	9299	11343
Hamtrk	53	142	611	991	114	168	557	956
HazlPk	198	208	828	1171	263	245	995	1376
HighPk	10	160	685	1036	3	185	634	1060
Hollnd	106	114	1050	1173	154	112	967	1089
Inkstr	124	206	905	1258	92	169	758	1079
Jacksn	95	359	2430	3029	38	296	2246	2784
Kalzoo	222	564	4533	5428	304	563	4258	5216
Kentwd	25	151	1092	1263	30	144	1222	1398
Lansng	105	879	6418	7319	227	835	5431	6283
LincPk	143	419	1708	2345	193	342	1444	1953
Livoni	264	539	3394	4069	401	516	3130	3806

Table 28 - Continued
1978 and 1979 Accident and DUIL Frequencies by City

City	1978				1979			
	Arrests	Accidents			Arrests	Accidents		
		HBD	HNBD	Total		HBD	HNBD	Total
Marque	39	224	1048	1405	21	197	975	1330
MdsnHt	73	250	1374	1630	86	249	1380	1634
Midlnd	38	195	1507	1709	52	173	1494	1677
Monroe	3	152	666	821	21	125	566	691
MtClem	81	127	821	1068	125	144	723	957
MtPles	7	100	669	779	20	87	623	725
Muskgn	31	307	2501	2830	84	326	2295	2634
NortSh	24	146	641	797	41	158	671	835
OakPrk	100	82	912	1149	185	64	913	1133
Pntiac	270	535	3505	4392	178	621	3332	4243
Portge	81	130	1245	1380	89	142	1294	1447
PrtHrn	7	269	1571	2029	53	234	1433	1896
Romuls	103	249	1289	1580	210	279	1147	1478
Rosvil	234	399	2121	2555	424	433	1930	2385
RoyOak	54	390	2289	2716	63	379	2244	2657
Sagnaw	79	546	4455	5032	134	626	3909	4572
Sthfld	233	423	3469	3915	302	408	3242	3688
Sthgte	88	277	1337	1742	151	263	1164	1515
StrHts	485	386	2628	3144	710	437	2618	3191
StClrS	384	200	780	1002	432	226	696	938
Taylor	280	529	2580	3261	302	481	2162	2812
Trentn	24	79	509	595	50	92	404	506
Troy	190	383	2322	2763	302	424	2221	2703
Warren	151	841	5534	6803	233	815	5087	6298
Westld	367	454	1801	2261	557	412	1765	2184
Wyandt	31	289	1098	1632	44	280	914	1401
Wyomng	88	299	2703	3099	93	366	2850	3321
Ypsila	141	209	1157	1471	210	212	1026	1332

Table 29
1978 and 1979 Accident Rates and Ratios by City

City	HBD'79 / HBD'78	Rank	'78HBD Rate	Rank	'79HBD Rate	Rank	'79Rate / '78Rate	Rank	'79Arsts / '78Arsts	Rank
Adrian	.974	32	.090	55	.103	53	1.134	11	1.467	25
AlnPrk	.886	45	.152	21	.140	33	.923	51	1.016	44
AnnArb	1.028	24	.123	36	.137	34	1.118	17	1.011	46
BatCrk	.862	49	.114	45	.110	46	.967	45	.944	48
BayCty	1.041	22	.149	23	.160	20	1.072	25	1.593	16
Birmgh	.857	50	.100	51	.084	55	.840	55	1	47
Burton	1.051	20	.193	4	.208	3	1.076	24	1.485	23
Detrot	1.049	21	.132	33	.146	31	1.107	19	1.056	43
DrbnHt	.855	51	.151	22	.152	26	1.005	38	1.452	28
Drborn	.922	41	.119	41	.126	40	1.055	27	1.247	35
EDetrt	1.024	25	.159	16	.175	17	1.101	21	.644	53
ELansg	1.041	23	.138	29	.155	24	1.126	15	.904	49
Ferndl	1.173	4	.237	1	.235	2	.992	42	.797	50
Flint	.989	29	.173	10	.189	5	1.093	22	2.754	4
FrmHls	1.147	8	.142	26	.148	28	1.042	32	2.547	6
GrdnCt	.974	31	.170	11	.179	12	1.055	28	1.015	45
GrRpds	1.101	15	.103	50	.104	49	1.015	37	1.474	24
Hamtrk	1.183	2	.143	25	.176	14	1.226	4	2.151	8
HazlPk	1.178	3	.178	8	.178	13	1.002	39	1.328	33
HighPk	1.156	7	.154	19	.175	16	1.130	13	.300	56
Hollnd	.982	30	.097	52	.103	52	1.058	26	1.453	27
Inkstr	.820	54	.164	12	.157	23	.956	46	.742	51
Jacksn	.825	52	.119	43	.106	48	.897	53	.400	55
Kalzoo	.998	27	.104	49	.108	47	1.039	33	1.369	30
Kentwd	.954	38	.120	40	.103	51	.862	54	1.200	36
Lansng	.950	39	.120	39	.133	38	1.107	20	2.162	7
LincPk	.816	55	.179	7	.175	15	.980	43	1.350	32
Livoni	.957	37	.132	32	.136	37	1.023	36	1.519	20

Table 29 - Continued
1978 and 1979 Accident Rates and Ratios by City

City	HBD'79 / HBD'78	Rank	'78HBD Rate	Rank	'79HBD Rate	Rank	'79Rate / '78Rate	Rank	'79Arsts / '78Arsts	Rank
Marque	.879	46	.159	14	.148	29	.929	50	.538	54
MdsnHt	.996	28	.153	20	.152	25	.994	40	1.178	37
Midlnd	.887	44	.114	44	.103	50	.904	52	1.368	31
Monroe	.822	53	.185	5	.181	11	.977	44	7	2
MtClem	1.134	10	.119	42	.150	27	1.265	2	1.543	18
MtPles	.870	47	.128	34	.120	43	.935	48	2.857	3
Muskgn	1.062	19	.108	47	.124	41	1.141	10	2.710	5
NortSh	1.082	18	.183	6	.189	6	1.033	34	1.708	14
OakPrk	.780	56	.071	56	.056	56	.792	56	1.850	11
Pntiac	1.161	6	.122	38	.146	30	1.202	6	.659	52
Portge	1.092	16	.094	54	.098	54	1.042	31	1.099	40
PrtHrn	.870	48	.133	31	.123	42	.931	49	7.571	1
Romuls	1.120	13	.158	17	.189	7	1.198	7	2.039	10
Rosvil	1.085	17	.156	18	.182	10	1.163	8	1.812	12
RoyOak	.972	33	.144	24	.143	32	.993	41	1.167	38
Sagnaw	1.147	9	.109	46	.137	36	1.262	3	1.696	15
Sthfld	.965	36	.108	48	.111	44	1.024	35	1.296	34
Sthgte	.949	40	.159	15	.174	18	1.092	23	1.716	13
StrHts	1.132	11	.123	37	.137	35	1.115	18	1.464	26
StClrS	1.130	12	.200	3	.241	1	1.207	5	1.125	39
Taylor	.909	42	.162	13	.171	19	1.054	29	1.079	41
Trentn	1.165	5	.133	30	.182	9	1.369	1	2.083	9
Troy	1.107	14	.139	28	.157	22	1.132	12	1.589	17
Warren	.969	34	.124	35	.129	39	1.047	30	1.543	19
Westld	.907	43	.201	2	.189	8	.939	47	1.518	21
Wyandt	.969	35	.177	9	.200	4	1.129	14	1.419	29
Wyomng	1.224	1	.096	53	.110	45	1.142	9	1.057	42
Ypsila	1.014	26	.142	27	.159	21	1.120	16	1.489	22

Table 30
1978 and 1979 DUIL Enforcement Indexes by City

City	1978 Index	Rank	1979 Index	Rank	1979 Index / 1978 Index	Rank	1978+1979 Index	Rank
Adrian	.129	49	.195	50	1.506	22	.162	49
AlnPrk	.555	17	.635	20	1.146	40	.593	19
AnnArb	.733	10	.721	16	.984	47	.727	13
BatCrk	.544	19	.596	23	1.095	42	.568	22
BayCty	.186	41	.284	40	1.530	21	.236	41
Birmgh	.324	31	.378	35	1.167	39	.349	35
Burton	.456	24	.645	19	1.413	28	.553	23
Detrot	.409	26	.411	32	1.006	44	.410	30
DrbnHt	.274	37	.465	30	1.699	13	.362	32
Drborn	.750	9	1.015	9	1.354	31	.877	9
EDetrt	.354	29	.223	47	.629	52	.288	37
ELansg	1.694	2	1.471	4	.868	49	1.580	3
Ferndl	.663	12	.451	31	.679	51	.549	24
Flint	.137	48	.381	34	2.786	4	.258	39
FrmHls	.211	39	.469	29	2.220	8	.349	34
GrdnCt	1.176	5	1.225	7	1.041	43	1.200	5
GrRpds	.302	34	.405	33	1.338	33	.356	33
Hamtrk	.373	28	.679	18	1.818	10	.539	25
HazlPk	.952	6	1.073	8	1.128	41	1.018	8
HighPk	.063	54	.016	56	.259	56	.038	56
Hollnd	.930	7	1.375	5	1.479	24	1.150	6
Inkstr	.602	15	.544	26	.904	48	.576	21
Jacksn	.265	38	.128	54	.485	55	.203	44
Kalzoo	.394	27	.540	28	1.372	29	.467	26
Kentwd	.166	44	.208	49	1.258	35	.186	46
Lansng	.119	50	.272	41	2.276	7	.194	45
LincPk	.341	30	.564	25	1.654	16	.442	28
Livoni	.490	23	.777	13	1.587	18	.630	15

Table 30 - Continued
1978 and 1979 DUIL Enforcement Indexes by City

City	1978 Index	Rank	1979 Index	Rank	1979 Index / 1978 Index	Rank	1978+1979 Index	Rank
Marque	.174	43	.107	55	.612	53	.143	52
MdsnHt	.292	36	.345	36	1.183	38	.319	36
Midlnd	.195	40	.301	37	1.542	20	.245	40
Monroe	.020	56	.168	51	8.512	2	.087	55
MtClem	.638	13	.868	12	1.361	30	.760	12
MtPles	.070	53	.230	45	3.284	3	.144	51
Muskgn	.101	52	.258	43	2.552	5	.182	48
NortSh	.164	45	.259	42	1.579	19	.214	43
OakPrk	1.220	4	2.891	1	2.370	6	1.952	1
Pntiac	.505	21	.287	38	.568	54	.388	31
Portge	.623	14	.627	22	1.006	45	.625	16
PrtHrn	.026	55	.226	46	8.704	1	.119	54
Romuls	.414	25	.753	14	1.820	9	.593	18
Rosvil	.586	16	.979	11	1.670	15	.791	11
RoyOak	.138	47	.166	52	1.201	36	.152	50
Sagnaw	.145	46	.214	48	1.479	23	.182	47
Sthfld	.551	18	.740	15	1.344	32	.644	14
Sthgte	.318	32	.574	24	1.807	11	.443	27
StrHts	1.256	3	1.625	3	1.293	34	1.452	4
StClrS	1.920	1	1.912	2	.996	46	1.915	2
Taylor	.529	20	.628	21	1.186	37	.576	20
Trentn	.304	33	.543	27	1.789	12	.433	29
Troy	.496	22	.712	17	1.436	27	.610	17
Warren	.180	42	.286	39	1.592	17	.232	42
Westld	.808	8	1.352	6	1.672	14	1.067	7
Wyandt	.107	51	.157	53	1.465	26	.132	53
Wyomng	.294	35	.254	44	.863	50	.272	38
Ypsila	.675	11	.991	10	1.468	25	.834	10

REFERENCES

[1] Flora, J.D., L.D. Filkins, and C.P. Compton, Alcohol Involvement in Michigan Fatal Accidents: 1968-1976, Report UM-HSRI-78-16, Highway Safety Research Institute, The University of Michigan, Ann Arbor, March 1978.

[2] Douglass, R.L., L.D. Filkins, and F.A. Clark, The Effect of Lower Legal Drinking Ages on Youth Crash Involvement, Report UM-HSRI-AL-74-1-2, Highway Safety Research Institute, The University of Michigan, Ann Arbor, June 1974. DOT HS-801 213.

[3] Office of Highway Safety Planning, Michigan's Eighteen-Year-Old Legal Drinking Age: Its Impact on Youth Crash Involvement, Michigan Department of State Police, Lansing, February 1977.

[4] Douglass, R.L. and J.A. Freedman, Alcohol-Related Casualties and Alcohol Beverage Market Response to Beverage Alcohol Availability Policies in Michigan: Volume 1, Report UM-HSRI-77-37, Highway Safety Research Institute, The University of Michigan, Ann Arbor, August 1977.

[5] Flora, J.D., "Michigan Fatal Accidents Involving Alcohol, 1968-1976," The HSRI Research Review, Highway Safety Research Institute, The University of Michigan, Ann Arbor, Volume 8, Number 5, March-April 1978.

[6] Wagenaar, A.C. and R.L. Douglass, An Evaluation of the Changes in the Legal Drinking Ages in Michigan, Report UM-HSRI-80-67, Highway Safety Research Institute, The University of Michigan, Ann Arbor, September 1980.

[7] Wagenaar, A.C. The Minimum Legal Drinking Age: A Time-Series Impact Evaluation, Ph.D. dissertation, The University of Michigan, Ann Arbor, 1980.

[8] Wagenaar, A.C., "Effects of the Raised Legal Drinking Age on Motor Vehicle Accidents in Michigan," The HSRI Research Review, Highway Safety Research Institute, The University of Michigan, Ann Arbor, Volume 11, Number 4, January-February 1981.

[9] Wagenaar, A.C., "Effects of an Increase in the Legal Minimum Drinking Age," The Journal of Public Health Policy, in press, Fall, 1981.

[10] VanLiew, J., Michigan Driver Improvement Annual Statistical Report: 1978, Report Number 4, Michigan Department of State, Lansing, April 1980.