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AUTHOR O'Malley, Patrick M.; Wagenaar, Alexander C.
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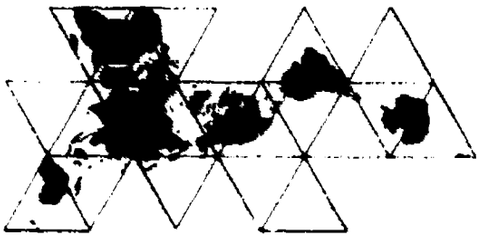
ABSTRACT

This research was undertaken to delineate cross-sectional differences among U.S. high school seniors and young adults that may be due to variations in recent years in state-level minimum drinking age laws, and to examine the effects of recent changes in minimum drinking age laws on alcohol consumption, and on other relevant attitudes and behaviors. Analyses were conducted using existing data collected by the Monitoring the Future project which involved national surveys of 15,000 to 19,000 high school seniors and annual followup surveys of recent graduates. The major findings were that: (1) higher minimum drinking ages were associated with lower levels of alcohol use among high school seniors and recent high school graduates, even after multivariate controls; (2) lower levels of alcohol use were observed across a broad spectrum of demographic variables; (3) the lower levels of use persisted into the early 20's, even though everyone was of legal age; and (4) lowered involvement in alcohol-related fatal crashes among drivers less than 21 years of age appeared to be due to less drinking of alcohol, in particular less drinking in bars or taverns. (Author/BHK)



monitoring the future

occasional papers

paper 28

MINIMUM DRINKING AGE LAWS
EFFECTS ON AMERICAN YOUTH
1976-1987

Patrick M. O'Malley
Alexander C. Wagenaar

Monitoring the Future: A Continuing Study of the Lifestyles and Values of Youth

As its title suggests, this study is intended to assess the changing lifestyles, values, and preferences of American youth on a continuing basis. Each year since 1975 about 17,000 seniors have participated in the annual survey, which is conducted in some 130 high schools nationwide. In addition, subsamples of seniors from previously participating classes receive follow-up questionnaires by mail each year.

This Occasional Paper Series is intended to disseminate a variety of products from the study, including pre-publication (and somewhat more detailed) versions of journal articles, other substantive articles, and methodological papers.

A full listing of occasional papers and other study reports is available from Monitoring the Future, Institute for Social Research, The University of Michigan, P.O. Box 1248, Ann Arbor, MI 48106.

MINIMUM DRINKING AGE LAWS

EFFECTS ON AMERICAN YOUTH

1976-1987

Monitoring the Future Occasional Paper 28

Patrick M. O'Malley
Alexander C. Wagenaar

Institute for Social Research
The University of Michigan
Ann Arbor, Michigan

1990

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ABSTRACT

The research described in this report had two separate but related purposes: (1) to delineate cross-sectional differences among American high school seniors and young adults that may be due to variations in recent years in state-level minimum drinking age laws, and (2) to examine the effects of recent changes in minimum drinking age laws on alcohol consumption, and on other relevant attitudes and behaviors.

The analyses utilize existing data collected by the Monitoring the Future project, an ongoing study involving (a) annual, nationally representative surveys of 15,000 to 19,000 high school seniors, and (b) annual follow-up surveys by mail of recent graduates. Thus, it was possible to assess the effects of different minimum drinking ages on young people in the critically important age range from 17 to over 21.

A separate, coordinated part of the research utilized official reports to examine effects on rates of fatal crashes following increases in the minimum drinking age in several states. These official report data are compared with the findings from self-report data available from high school seniors.

The major findings are: (1) higher minimum drinking ages are associated with lower levels of alcohol use among high school seniors and recent high school graduates, even after multivariate controls; (2) lower levels of alcohol use are observed across a broad spectrum of demographic variables; (3) the lower levels of use persist into the early 20's, even though everyone is of legal age; (4) lowered involvement in alcohol-related fatal crashes among drivers less than 21 years of age appears due to less drinking of alcohol — in particular, less drinking in bars or taverns.

Introduction

The research described in this report had two separate but related purposes: (1) to delineate cross-sectional differences among American high school seniors and young adults that may be attributed to variations in state-level minimum drinking age laws, and (2) to examine the effects of recent changes in minimum drinking age laws on alcohol consumption, and on other related variables, including alcohol-related automobile crashes and other health-related behaviors.[1]

The first purpose of the research is accomplished by examination of *self-report data* from annual surveys of high school seniors on their own alcohol-related behaviors, primarily consumption. The research also provides information on the extent to which minimum drinking age laws affect a broad array of other measures; more specifically, there are measures available on: (a) driving violations and traffic crashes following use of alcohol; (b) circumstances or setting of alcohol use; (c) reasons for drinking; (d) degree and duration of intoxication; (e) attitudes toward drinking; (f) use of other psychoactive substances; (g) delinquent behaviors and victimization experiences; (h) truancy; and (i) grade of first use of alcohol. The self-report data on crashes and violations provide information beyond that contained in official record systems; many minor crashes are not reported in official records, and information on the involvement of alcohol use is frequently not available for those events that are included in official records.

In addition to the annual surveys of seniors, sub-samples of each senior class are followed up after high school graduation. The dataset thus provides an opportunity to investigate the effects of different minimum drinking age laws on large samples of young Americans as they make the important transitions from high school students to young adults, and as they move through a part of the life cycle during which they are at high risk for alcohol-related problems.

The second purpose is to look at the effect of *changes* in minimum drinking ages. Before-and-after data are available in a total of 26 states that raised their minimum drinking ages between 1976 and 1987. In addition, effects of changes in minimum drinking ages on official crash statistics in specific states are compared with effects on self-report data.

Rationale and Background

Between 1970 and 1988, there were major fluctuations in minimum drinking age laws in the United States.[2] In the early 1970s, many states lowered the minimum age for drinking from 21 to 18, 19, or 20. Many of those same states raised the minimum age in subsequent years. The latter raises were impelled largely by beliefs that there were significant increases in the incidence

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1. The term "crash" is used rather than the more common colloquial term "accident" in order to emphasize that automobile crashes are not simply random, unavoidable events.

2. The term "minimum drinking age" law is necessarily somewhat imprecise; some of the laws referred to specify a minimum age for purchase of alcoholic beverages, others specify a minimum age for consumption or possession, etc. In spite of its imprecision, "minimum drinking age" seems to be the term most commonly used in the literature and in the policy debates; accordingly, we will continue the practice.

of alcohol-related traffic crashes involving the newly-enfranchised drinkers. A major impetus for raising the age was a federal law passed in 1984 that required states to have enacted a minimum drinking age of 21 by October of 1986, or face the loss of a portion of federal highway funds beginning in 1987. Almost all of the states that did not have a minimum age of 21 at that time subsequently passed legislation to raise the age to 21 by 1987,[3] and by 1989 all had done so (Distilled Spirits Council, 1989).

Although by 1988 all states prohibited purchase of alcoholic beverages of any kind by anyone under age 21, as recently as 1982 only fourteen states prohibited purchase of alcoholic beverages of any kind by anyone under the age of 21, while the others varied considerably in permitting purchase of at least some types of alcohol to persons between the ages of 18 and 20. In those states where purchase of alcohol at age 18 was permitted, a significant proportion of high school seniors were eligible; in the Monitoring the Future surveys (which occur late in senior year), between a quarter and a half of the participating seniors are 18 or older. An important question that the current analyses address is: *What effects did these differing minimum drinking ages have on the behaviors and attitudes of America's high school seniors?*

The answers to this question can have important policy implications because the debate about the wisdom of a minimum age of 21 is likely to continue, especially in other countries with lower legal ages. And in this country, it behooves a society that allows 18 year old citizens to enjoy the rights, privileges, and responsibilities of adults, with one major exception, to be very clear as to the justification for that exception. Even in the absence of any real debate, it will nevertheless be useful, from a scientific and practical view, to know the implications of different minimum age laws. As the National Institute on Alcohol Abuse and Alcoholism stated: "Additional research is needed to provide information that will enable legislators and the public to make decisions about the degree of cause and effect between minimum drinking age laws and drinking behavior by youth" (National Institute on Alcohol Abuse and Alcoholism, 1981). That statement is still true.

Previous research on minimum drinking age laws has dealt primarily with the effect of changes in those laws on the frequency of traffic crashes, particularly alcohol-related crashes, among young people. There is much less research that has looked at the extent to which variations among states in minimum drinking ages appear to be associated with differences in individual behaviors and attitudes. In support of a lower minimum drinking age, it has been argued that, "as a group, people aged 18-20 are extraordinarily prone to . . . violent crime and other forms of socially destructive activity, and it is simply foolish to exacerbate these tendencies by legalizing drinking for this age group" (Moore & Gerstein, 1981, pp. 77-78). There is, however, little direct evidence that these tendencies are in fact exacerbated (other than in the case of motor vehicle crashes). Vingilis and DeGenova (1984) noted in their review of the effects of changes in minimum age laws that data on consumption level and alcohol-related delinquency are indeterminate. A counter argument to the idea that socially destructive tendencies are decreased by higher minimum ages is that minimum drinking age laws simply delay the time when young people can learn to drink responsibly, and that the laws have undesirable effects, including prolonging pre-adult behaviors of rebelliousness and other socially destructive tendencies (Zylman, 1976); increasing cynicism toward the government, and increasing disregard for law

3. Some of the late-changing "reluctant" states made the higher minimum drinking age effective after the spring 1987 data collection, and therefore the change is not shown as effective in 1987 in Table 3, below.

enforcement (Smith, Hingson, et al., 1984); and a variety of other negative psychological consequences (Newman, 1987). Except for studies of traffic crashes, the paucity of credible data leaves the debate unresolved and unenlightened.

Maisto and Rachal (1980) were able to locate only two studies of state minimum drinking age laws that examined general patterns of drinking behavior prior to 1980 (Zylman, 1976; Rooney and Schwartz, 1977). Maisto and Rachal's study is more comprehensive than the earlier studies in the literature, so only their research will be briefly reviewed here. Maisto and Rachal present results from "an assessment of differences in drinking patterns among youth in states with different minimum drinking ages" (1980, p. 155). Their research effort — unique in having a nationally representative school-based sample — was somewhat similar to that which is reported here, although there are some important differences that will be noted after a brief discussion of their findings.

The dataset used by Maisto and Rachal was based on the 1978 Survey of Adolescent Drinking Behavior, conducted for the National Institute on Alcohol Abuse and Alcoholism (Rachal et al., 1980). This nationally representative sample consisted of 4,918 students in grades 10, 11, and 12, clustered in 74 schools. Three groups defined in terms of minimum ages were compared on a number of dependent variables, all related to alcohol. Generally the major findings were that (a) respondents from states with minimum drinking ages of 18-20 or "mixed" ages differed rather little; and (b) respondents from states with a minimum age of 21 showed less involvement with alcohol among high school students than did the other states.

The Maisto and Rachal study is quite significant in demonstrating that differences do appear to exist between states with different minimum drinking ages. However, the research reported here augments and expands on that study in several important ways:

1. The repeated cross-sectional design of the Monitoring the Future study extends over a longer time period (1976-1987), and the findings are thus less likely to be distorted by sampling error, or to be true of only one particular time period. Further, any observed relationship can be examined to see whether it replicates across samples and time, making the results less susceptible to the criticism that other factors that may be correlated with drinking age could explain the differences.

2. There are many more schools involved in the Monitoring the Future surveys, thus increasing confidence in the generalizability of the results, and decreasing the sampling error due to clustering by school. (There were a total of 1,637 school administrations conducted between 1976 and 1987.)

3. There exists a broader array of dimensions along which differences can be observed, made possible because the design incorporates multiple questionnaire forms.

4. We can analyze differences in self-reports of crashes and driving violations that occur after drinking alcohol (or using marijuana or other drugs).

5. Because of the very large number of cases (over 200,000), we can more readily investigate whether minimum drinking age laws show any differential association

between population subgroups. For example, minimum drinking age laws could affect rural students' behavior more than urban students.

6. The follow-up data allow for longer term assessment of any differential effects. Through the 1987 follow-up, approximately 18,000 individuals aged 19-27 will have completed one or more questionnaires.

7. Because of the many recent changes in minimum drinking age laws, we can assess the effect of these changes across a large number of states on a broad array of measures.

Since the Maisto and Rachal study, there have been some additional studies reported on the effect of minimum drinking age laws on self-reported alcohol use. Most of these have been relatively small studies, dealing with only a single state (for example, Williams & Lillis, 1986, 1988) or a smaller site (for example, George, Crowe, et al., 1989; Hughes & Dodder, 1986). Grossman, Coate, and Arluck (1987) and Coate and Grossman (1988) have used data from national health surveys to demonstrate some effects of minimum drinking ages on self-reported alcohol use. The first of these studies obtained a usable sample of 790 youths ages 16 through 21, located in 32 large metropolitan areas. The second study obtained data from 1,761 youths living in 63 sampling areas. Both studies showed a negative association between minimum drinking age and beer consumption. The current research will add to this research by utilizing different methods (school-based samples), greater numbers of cases, a more extended time period, a broader array of independent variables (that is, variables used as predictors of alcohol use), a broader array of dependent variables (that is, variables other than alcohol use), and by looking at the effects of *change* in minimum drinking age.

As indicated earlier, much of the existing research has dealt with the effects of law changes on automobile crashes. Many of the early studies used methods, or had databases, that were inadequate to provide strong evidence on effects; but more sound research has been done in recent years.

Two groups of Canadian researchers assessed the effect of changes in Canadian minimum drinking age laws (Smart, 1976, 1979, 1980; Whitehead, 1977, 1980); their general conclusion was that decreased minimum drinking ages were followed by increased involvement of young people in alcohol-related motor vehicle crashes.

In the United States, a number of researchers have investigated the effects of changes in various state laws, or have reviewed such studies; the predominant finding or conclusion is that there is a negative association between the minimum age and the amount of alcohol-related driving problems among 18-20 year olds. Studies supporting this proposition include: Cook et al. (1984), Douglass (1980a, 1980b), DuMouchel et al. (1987), Hingson et al. (1983), Hoskin et al. (1986), Lillis & Williams (1984), MacKinnon & Woodward (1986), Saffer & Grossman (1987), Van Dyke and Womble (1988), Wagenaar (1981a, 1981b, 1982b, 1983a, 1983b, 1986), Wagenaar & Maybee (1986), and Williams et al. (1983). These studies have not gone unchallenged, however; other researchers have suggested that any effects of minimum drinking age are really quite small (Choukroun, Ravn, & Wagner, 1985), or are very inconsistent across age groups or across different measures of alcohol-related problems (Bolotin & DeSario, 1985; Males, 1986; Smith et al., 1984), or perhaps only postpone fatalities to later ages (Asch & Levy, 1987). The challenges notwithstanding, the predominant conclusion seems to be that raising the minimum

drinking age to 21 decreases the number of alcohol-involved fatal crashes in the 18 to 20 year old age group.

The research to date has demonstrated that significant reductions in automobile crash involvement follow an increase in the drinking age, and has stimulated numerous questions concerning the effects of raised drinking ages on alcohol consumption and drinking-driving patterns among young people. Research to date, however, has not clarified the intervening mechanisms through which the change in law causes reduced crash involvement. For example, (a) Are youth drinking to excess on fewer occasions? (b) Are youth drinking on fewer occasions (with about the same amount consumed per occasion)? (c) Are youth drinking about the same amount with about the same frequency, but less often driving after drinking? The present study is designed to help answer these questions by assessing the effects of the legal drinking age on individual attitudes and behaviors, rather than aggregate alcohol sales or crash frequencies.

Methods

The Monitoring the Future project is an ongoing study of lifestyles and values of American youth; among other things, it monitors licit and illicit drug use, and a wide range of potentially related dimensions, among youth in their late teens and throughout their twenties. The project is funded by the National Institute on Drug Abuse, and a number of reports on drug use trends since 1975 have been published. Detailed information about the research design and data collection procedures may be found in Bachman and Johnston (1978), Bachman, Johnston, and O'Malley (1988), or Johnston, O'Malley, and Bachman (1988). Here, only a brief description will be given. The research design consists of: (a) a series of annual, nationwide questionnaire surveys of seniors in high schools; and (b) annual follow-up surveys mailed to subsets of each sample after their graduation. Thus the population of interest consists of most young American men and women in the 18 to 30 age range. Table 1 illustrates the cohort-sequential design.

Procedures

Base-year procedures. The initial base-year data collection is conducted in about 112 public and 18 private high schools selected to provide an accurate cross-section of high school seniors in the 48 contiguous states. The schools are selected by the Sampling Section of the University of Michigan's Survey Research Center; they are located in the primary sampling areas used by the Survey Research Center for personal interview studies, and local Survey Research Center interviewers administer the questionnaires in the schools. In a multi-stage sampling procedure, geographic areas are selected, then schools, and finally, seniors. Between 15,000 and 19,000 seniors participate each year. An important feature of the design is that each school is asked to participate for two years; thus, each year half of the schools are participating for the first time and half are participating for the second time.

Follow-up procedures. As indicated in Table 1, follow-up surveys have been conducted since 1977; the design calls for follow-up surveys to be mailed to a subset of each base-year sample following graduation. From each senior class, 2,400 participants are selected for follow-up. These 2,400 are randomly divided into two separate groups, each numbering about 1,200. Members of one group are invited to participate in the first year after graduation, and every two

years after that; those in the other group are invited to participate in the second year after graduation, and every two years after that. The result of this approach is that individual participants are surveyed on a two-year cycle, beginning either one or two years after graduation. Respondents are paid $5 for each follow-up participation. The follow-up samples are drawn so as to be self-weighting except that users of illicit drugs are over-sampled for follow-ups (by a factor of three to one). Consequently, over-sampled respondents receive a weight of 1/3 and all other respondents are weighted 1; these weights are used in all analyses to adjust for the differential selection probabilities. These follow-up procedures were initiated beginning with the follow-up of 1978. The class of 1976 follow-up of 1977 differed in that respondents were not paid for participation, so response rates in that year were somewhat lower. With the exception of that panel, response rates have ranged from 86% to 70%.

Measures. The exact wording of questions and response scales for all measures can be found in Bachman et al. (1987); a brief definition of each variable can be found in Appendix B.

Representativeness and Validity

Representativeness: Base-year. More detailed discussion of the issues of the representativeness of the sample and the validity of the data are included in Johnston et al. (1988), but a few observations are in order here. First, we believe that the sample of schools is reasonably representative of all high schools in the United States. When a sampled school is unwilling to participate, a replacement school is selected, controlling for factors such as urbanicity, geographical region, size, racial composition, and other relevant factors, insofar as possible. Reasons for unwillingness by some schools to participate are generally unrelated to the survey content.

Second, because the questionnaire administrations are routinely scheduled for a single day (on Tuesday, Wednesday, or Thursday), respondents who are absent on the day of the survey (usually about 18%) are excluded from the surveys as are any seniors who decline to participate (a very small percentage, less than 1%). Those individuals who have dropped out of high school (about 15 to 20% of the age cohort — Stern and Chandler, 1988, p. 28) are also excluded from the survey population. The exclusion of absentees and dropouts may seem to be a major problem for a study of illicit drug use (and perhaps for the current research as well). In fact, it is not nearly so serious a problem as it may seem initially, as will be discussed below.

It is true that absentees, on the average, tend to have somewhat higher rates of drug use (Kandel, 1975).[4] Some absentees are "truants" who would be expected to be more deviant and more involved in drug and alcohol use than others. But many absentees are "average" students who just happen to be absent on the survey day; others are seniors involved in extracurricular activities, and these absentees would tend to be lower in drug use; these factors tend to dampen the difference in prevalence rates. In the questionnaires, seniors are asked some questions on how often (and why) they have been absent recently. Responses to these questions can be used to reweight the data to estimate what overall prevalence rates are (that is, if absentees were

4. The higher rates do not necessarily carry over beyond high school; Kandel, Simcha-Fagan, and Davies (1986) have reported that by age 24-25, former absentees do not differ from former regular students in their extent of current drug involvement.

included). We have done this, and found that overall rates of drug use are only slightly underestimated when absentees are excluded (Johnston and O'Malley, 1985). More important, so long as absentee rates (and the reasons for absenteeism) are reasonably constant, *trends* should be affected either minimally, or not at all. For purposes of the present research, *comparisons among states cross-sectionally* and *comparisons of data collected before-and-after law changes* are more important than absolute levels; so long as the biases operate similarly in the various states and similarly over time, these comparisons will not be affected.

Third, the exclusion of dropouts results in a somewhat greater bias in prevalence rates. Again, trends across time should not be significantly affected, because dropout rates have been quite constant since about 1975 (Stern and Chandler, 1988, p. 29). Plausible estimates of the prevalence rates among dropouts, based on data from a few studies that have included dropouts (Johnston, 1973; Abelson et al., 1977; Fishburne et al., 1979), can be used to determine an estimate for the overall age cohort. The resulting biases are not dramatic, largely because the dropouts represent only about 15-20% of the population. Lifetime and annual use prevalences for alcohol are underestimated by rather little — 1% and 2%, respectively. We should also note that, after a technical review of the issue of absentees and dropouts, Clayton and Voss (1982) concluded:

> ... the analyses provided in this report show that failure to include these two groups (absentees and dropouts) does not substantially affect the estimates of the incidence and prevalence of drug use.

And to reiterate, in the present research the emphasis is on differences between states and on trends over time, and the exclusion of absentees and dropouts would be less likely to affect these comparisons.

In sum, while it certainly would be desirable to have both absentees and dropouts included in the surveys, to do so would very substantially increase costs, while only slightly increasing accuracy of prevalence rates. Furthermore, accuracy of trends or comparisons would be improved only minimally, if at all.

Representativeness: Follow-up. All large-scale longitudinal surveys inevitably suffer from some panel attrition, and the follow-up data collections in this research are no exception. By the end of the 1987 data collection, there were 1-year follow-up panels from the classes of 1976-1986, followed up in 1977 through 1987, respectively. Across the eleven classes, the average response rate for the follow-up one-year after graduation was 83.3%. By 1987, there had also been 2-year follow-ups of ten classes, 3-year follow-ups of nine classes, and so on. Naturally, the response rate declines with years after high school. Table 2 indicates the average response rates for the various follow-up intervals. As the table indicates, approximately 83% of the seniors sampled for follow-up participate in the first year follow-up; the figure tails off after that, but even seven or eight years after graduation (when respondents average 25-26 years old), rates are around 75%.

Of course, those who continue to participate are likely to be somewhat different from those who do not, and the likely effect is to underestimate behaviors such as drinking, drinking to excess, or driving after drinking. If alcohol use were higher in states with low drinking ages, and if alcohol were substantially correlated with the likelihood of participation, that could lead to a bias.

However, we believe that attrition is unlikely to bias seriously the present analyses. Evidence in support of this assertion is provided by some unpublished results of attempts to predict follow-up participation rates from base-year measures. An extensive set of predictors, including demographic and behavioral measures, was able to explain only about 6% of the variance in participation in later follow-ups. Significantly, alcohol use was not an important predictor, and did not even enter the regression in a step-wise procedure. (The most important predictors were factors associated with successful academic performance, including grades, truancy, etc.)

Further evidence that attrition is unlikely to be a problem was provided by some previous analyses of the follow-up data to be utilized in the present research. There, we reweighted the data to obtain estimated overall prevalence rates, adjusted for non-participation so as to eliminate at least some of the bias (O'Malley, Bachman, & Johnston, 1988).[5] This procedure was carried out for each prevalence measure for each of a number of licit and illicit substances, for each follow-up panel. The adjusted follow-up prevalence measures are, as one would expect, higher than the unadjusted figures, though not dramatically so. The most relevant one for present purposes is alcohol: in the 1982 follow-up of the classes of 1976-1981, 30-day prevalence of any alcohol use was increased by 0.3% (from 78.2% before adjustment to 78.5% after adjustment), and the 30-day prevalence of daily use was increased by 1.0% (from 7.7% to 8.7%). A measure of heavy drinking (having 5 or more drinks in a row on at least one occasion in the prior two weeks) increased by 1.7% (from 40.3% to 42.0%). We should note that the adjustments are rather minimal in part because participation rates are fairly high (around 80%), and because the financial inducement to participate probably reduces the degree to which willingness to participate varies among subgroups.

For present purposes, because we are making comparisons between states, adjusting for the effects of attrition is less crucial than if we were trying to estimate prevalence rates; therefore, in the analyses reported here, we make no attempts to correct for attrition. (We do, of course, apply weights to adjust for the differential probabilities of selection into the follow-up panels.)

Validity. An additional issue of particular concern in this study is the validity of self-report data, a basic question in all survey research. Although there is very likely some degree of underreporting of illegal drug use on self-report surveys, most research has shown that it is of a rather small magnitude in self-completed, confidential questionnaires in normal populations (Benson & Holmberg, 1985; Single, Kandel, & Johnson, 1975; Smart, 1975). Alcohol use in the general population tends to be somewhat more under-reported; amount of reported consumption is generally considerably lower than sales figures would indicate. Room (1971) estimates that self-reported consumption is about one-third less than what sales figure would indicate, although some later careful research suggests that the bias in consumption is probably on the order of 20% (Polich, 1981). There are several reasons for the discrepancy other than a tendency to under-report. One is that typical surveys miss certain segments of the population, including transients, military personnel, hotel or college dormitory residents, hospitalized people (including alcoholics in treatment), all of whom may be heavier-than-average drinkers. Another is that surveys often obtain the cooperation of about 70-80% of the population, and the nonparticipants are likely to be somewhat higher in drinking rates. We suspect that the bias is not so strong in the high school

5. Essentially, the procedure used is to reweight participating follow-up respondents so that each follow-up panel has, when reweighted, the same base-year prevalence as the total base-year sample for that class-year.

senior population; we base this belief on a number of facts. One fact is that seniors report very high prevalence levels; in particular, about half of the males and one-third of the females report having had five or more drinks on at least one occasion in the prior two weeks. Furthermore, seniors are relatively more accepting of this kind of episodic drinking (large amounts occasionally) than they are of sustained daily drinking at even moderate levels of one or two drinks per day (Johnston et al., 1988). And it is likely that it is underreporting of sustained frequent drinking that accounts for the major share of the underreporting in normal population surveys. More importantly, as is true for other potential biases in prevalence rates, any underreporting of substance use should have very minimal effects on trend estimates, or on between states comparisons, or on comparisons of before-and-after law changes.

Sampling error. Finally, in addition to the non-sampling errors related to representativeness and validity just discussed, there exists sampling error, error that is introduced because observations are made on a sample rather than on the entire population. In the reports from the study on drug use, detailed tables of confidence intervals are provided for statistics derived from the samples (Johnston, O'Malley, & Bachman, 1983). On the whole, the samples are providing a high level of accuracy, permitting the reliable detection of rather small shifts from one year to the next. While there is not the same extraordinary degree of precision in the present analyses having to do with minimum drinking ages , there are sufficient numbers of states, schools, and individuals so that any socially significant differences or effects are clearly discernible.

In concluding this discussion of representativeness and validity, let us repeat an important point made at several places in this study: biases affect primarily overall estimates. To the extent that biases are similar across states then comparisons among states would be affected very little or not at all; similarly, comparisons of behaviors before-and-after law changes should not be affected.

Analysis

There are two major aspects to the analyses, corresponding to the two aims of the project. These involve: (1) analyses of the cross-sectional (that is, differences *between* states) differences associated with minimum drinking ages, and (2) analyses of the effect of law changes over time (differences *within* states). Each of these major aspects involve additional analytic issues, to be discussed below.

The analyses took several forms. In the between-states analyses, univariate analysis of variance was used to compare alcohol use by minimum drinking age categories. These analyses utilized different sets of states within different time intervals, as described below. Following the univariate analyses of variance, multivariate controls were introduced, using multiple linear regressions, to determine whether minimum drinking age effects could be explained or attenuated by other variables. These analyses utilized the data provided by high school seniors. Then, similar analyses were extended to follow-up data collections, examining the effect of minimum drinking ages on alcohol use in the post-high school years through age 25.

The second major analysis phase examined the effect of changes in minimum drinking ages. Univariate analyses of variance were again used, this time to compare alcohol use before and after the change in minimum drinking age. Adjustments for secular trends were incorporated to ensure that apparent effects of change are not spurious. Possible differential effects of change in

minimum drinking age on population subgroups were examined. The effects on variables other than alcohol use were also examined.

The final phase, part of the study of change, examined official statistical data in a restricted set of states that provided appropriate data before and after a change in minimum drinking age. In this phase, the official statistics, provided by the National Highway Traffic Safety Administration's Fatal Accident Reporting System (FARS), were analyzed by time-series procedures. In addition to data on fatal crashes, the distribution of licensed drivers by age were obtained from the Federal Highway Administration, and these data were used to control for changes in the numbers of licensed drivers by age group.[6] Thus the major dependent variables in the time-series analyses were the natural logarithms of the raw frequency of fatalities, and (more important) the fatality rates per number of licensed drivers for the relevant age groups. The time-series methods used are similar to those used and explained in detail in Wagenaar (1983). Briefly, Box-Jenkins and Box-Tiao (Box & Tiao, 1975; Box & Jenkins, 1976) methods were employed to control for long-term trends and seasonal cycles and to estimate any effects beginning the first month after the laws were changed. All dependent time-series variables used natural logarithm transformations to reduce heteroscedasticity. Intervention variables captured any abrupt permanent effect of minimum drinking law change. Findings of the time-series analysis of official statistics were then compared with the self-report data for the same time periods and states.

Descriptive Data

First, we report some descriptive data regarding the numbers of students and schools in the various states, along with the minimum drinking age laws. These laws vary by type of alcoholic beverage (beer, wine, and distilled spirits), and for beer and wine, by percent of alcohol content. There are basically five different types of beverage alcohol: beer with low alcohol content (usually less than 3.2%) and beer with higher alcohol content, wine with low content (usually less than 14%) and wine with higher content, and distilled spirits. (More recently, wine coolers have been added to the available alcoholic smorgasbord; questions that specifically addressed wine coolers were added to the surveys in 1988, but have no relevance here.) While many states make no distinction among beverage types and have only a single minimum drinking age, some other states do make such distinctions; however, analyses indicated that the important distinction turned out to be the minimum drinking age for beer (which is of course the primary beverage of choice among American teenagers), and thus the other distinctions seem to be relatively unimportant. For states represented in the Monitoring the Future dataset, three different versions of the minimum drinking age will be distinguished for analysis purposes, and, generally, only the two extremes will be discussed.

In the first category are those states that permitted 18-year old individuals to purchase alcohol either without any further distinctions or with some restrictions on type of beverage; these are the "low age" states. In the second category are those states that did not permit 18-year-old individuals to purchase any alcohol at all, but did permit 19- or 20-year-olds to purchase at least

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6. The number of estimated vehicle miles traveled was also examined as a possible covariate but was not used in the analyses because age and time-specific travel data were not available and because frequency of fatalities failed to show the expected positive association with vehicle miles traveled.

some type of alcohol. The third category is comprised of those states whose minimum drinking age was 21 for any form of beverage alcohol; these are the "high age" states. More extensive categorizations were examined in preliminary analyses, but because of small numbers of cases in some groups (particularly those involving variations in age according to beverage), and because the above categorization related to drinking behavior in a sensible and consistent manner, the other possibilities were not pursued. Furthermore, the above categorization is conceptually desirable. No state requires a minimum drinking age older than 21, so that is a reasonable top category. No state's minimum drinking age is less than 18 for alcohol, and because beer is the beverage of choice, 18 for beer (and possibly other forms of alcohol) is a reasonable bottom category. The middle category is a reasonable intermediate category, at least for the early years of the interval under consideration. (By the end of the interval, 1987, virtually all seniors were in the age-21 category.) Table 3 provides an indication of minimum drinking age for all 50 states plus the District of Columbia (hereafter referred to as if it were a state) for the years 1976 to 1987. For purposes of completeness all states are included in Table 3, but some of these states were not included in any of the Monitoring the Future surveys, specifically, Alaska, Hawaii, Idaho, Montana, Nevada, New Mexico, Rhode Island, and Vermont. (Appendix Table A1 provides a more detailed listing of the nature of law changes, including specific dates and an indicator as to whether there was a grandfather clause.) Tables 4 and 5 provide (unweighted) numbers of students and schools, respectively, by states and years.[7,8]

One major feature of the data is that there was considerable variation between 1976 and 1987 in the numbers of young people under age 21 who were eligible to purchase alcoholic beverages. The passage of a federal law withholding funds from states that allowed purchase of alcohol by people under age 21 led nearly all states to require a minimum age of 21 by 1987. Thus, the percentage of seniors in the Monitoring the Future surveys who resided in states where one could not purchase any type of beverage alcohol before age 21 rose from 31.8% in 1976 to 95.5% in 1987, as shown in Table 6. One direct effect of this shift is that analyses that look at cross-sectional differences between states with varying minimum drinking age laws must be confined to less than the entire 1976-1987 interval; the interval 1976 to 1981 provides considerable variation for present purposes, and is therefore utilized in the cross-sectional analyses. Many states — essentially *all* states that did not have a constant minimum drinking age of 21 throughout the entire study interval — changed their laws between 1976 and 1987, and therefore there are a variety of "case-studies" where we can compare data collected before and after a change. Because any one state would not ordinarily contribute sufficient numbers of schools or students for adequate representativeness, these analyses pooled data across states and years.

Before proceeding to the results, brief digressions to discuss two issues related to analysis procedures may be helpful.

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7. As part of an assessment of changes in state laws related to marijuana, some schools in some states were asked in 1976, 1977, and 1978 to participate beyond the normal 2-year period; this resulted in higher numbers of schools and seniors in California, Maine, and Ohio in those years.

8. These numbers do not represent unique schools; because nearly all schools participate for two years, the number of unique schools is approximately half that shown in Table 5. The numbers of seniors in Table 4, on the other hand, do refer to unique cases.

Digression 1: Eligibility of Particular Individuals. The first issue relates to the eligibility of particular individuals with respect to purchasing alcoholic beverages. Determination of the precise state law regarding minimum drinking age at the time of questionnaire administration is often difficult, particularly given the many law changes that have been enacted during the study period. Published tabulations frequently cite only the year that a law was changed, without specifying whether the date refers to when legislation was passed, or what the effective date of legislation is, or whether any grandfather clauses were in effect. The problem is compounded by the fact that states vary in how laws are put into effect. Some, for example, may have laws take effect a certain period after the close of the legislative period; others typically have laws take effect on a specific date each year, often July 1; other states will specify an effective date in the statute itself.

A further difficulty in the present dataset is that we have individuals of varying ages (known only to nearest month) reporting across periods of 2 weeks, 30 days, 12 months, and lifetime. For most purposes, it seems best to focus on the shorter 2-week or 30-day intervals. If the status of particular individuals' eligibility to purchase alcohol were important, then it would be necessary to exclude from analyses those cases where it would be ambiguous as to whether an individual is eligible or not to purchase alcoholic beverages. However, it is important to note that the present analysis of minimum drinking age law effects does *not* focus on whether a given individual's behavior is affected by his or her own eligibility; rather, these analyses are focused on the broad effects on the behavior of high school seniors in general as a function of state-level drinking laws. A specific question to be answered is: do high school seniors in general (regardless of their own individual legal status) drink more, or more problematically, in states where only those age 21 or above have legal access to beverage alcohol compared to high school seniors in states where 18-year old citizens have legal access? To answer this question, it is not necessary, nor even desirable, to utilize fine grain knowledge of individual ages and precise dates of individual eligibility. For example, if even one senior in a group is eligible for purchasing alcohol, that might facilitate many other individuals' drinking behavior, and that facilitation could occur even if eligibility has no effect on the drinking behavior of the one eligible individual. Consequently, in the present analyses it is not particularly relevant whether a *given individual* is below or above the minimum drinking age level. (Needless to say, there are many circumstances wherein one may well be concerned with a given individual's own eligibility, and how that may affect behavior.)

Digression 2: A note on weighting. The second issue worthy of a brief digression is that of weighting. Ordinarily, a weight factor is applied to analyses of this dataset in order to compensate for differential probabilities of selection. In analyses that use a small number of states — at the limit, when looking at only one state — the function of the standard weight is problematic. The weight adjusts for differential selection probabilities that, strictly speaking, make sense only with respect to representation at the geographical region level. On the other hand, generally speaking, using the weights may well be more appropriate in representing the set of all states with similar minimum drinking age laws and law changes. Still, because the rationale for weighting is questionable at times, all important analyses have been run both weighted and unweighted (more accurately, weighting each case by unity) to assure that weighting does not affect the conclusions.

Results

Cross-Sectional Analyses

Minimum Drinking Age Differences: 1976-1981

We begin by comparing states that maintained different, but unchanged, minimum drinking ages throughout the period from 1976 to 1981. Use of this interval provides a relatively constant environment with enough sample cases for analysis. Three groups of states will be distinguished (although only the two extreme groups are large enough for most analysis purposes): (1) those with a minimum drinking age of 18 for at least *some* alcoholic beverages throughout the entire 1976 to 1981 interval; (2) those with a minimum age of 21 for *all* alcoholic beverages in that interval; and (3) the remaining states with any other unchanged minimum age law. Table 7 summarizes the overall numbers of participants providing data by the three categories. Only Maine and Minnesota changed minimum drinking age category between 1976 and 1978, while eleven states (Florida, Georgia, Illinois, Iowa, Massachusetts, Michigan, Montana, New Hampshire, New Jersey, Rhode Island, and Tennessee) changed their minimum drinking age category between 1979 and 1981.[9] As Table 7 indicates, questionnaires were administered to a total of 41,569 seniors located in 16 states with a constant minimum drinking age of 18 throughout the 1976 to 1981 interval, and to 33,429 seniors in 10 states with a constant minimum drinking age of 21. An additional 4,137 seniors were located in states with an intermediate minimum drinking age.

The results show some clear differences in alcohol use associated with the different levels of minimum drinking age. The most reasonably behaved variable seems to be 30-day alcohol use, measured on a 7-point scale ranging from 1 (0 uses) to 7 (40 or more uses). The scale is not an interval scale; each additional unit above zero represents roughly twice as many occasions of drinking (except for the top value of 7, which is unbounded). Although the scale is not interval, extensive analyses have demonstrated that it behaves quite well in analytic procedures that assume interval scales; see Bachman, O'Malley, and Johnston (1979) for details. The difference in alcohol, displayed in Figure 1, is in the expected direction: states allowing 18-year olds to purchase alcohol have higher rates of alcohol use among high school seniors compared to states that limit purchase to 21 years. The differences are not very large in absolute terms; the vertical scale in Figure 1 represents approximately one standard deviation (1.6). Combined across the entire six years, the mean for the 18-age states is 2.834 and the mean for the 21-age states is 2.605; the difference of 0.229 is about 14% of a standard deviation. The data from the third group of states (those states allowing some alcohol purchase for 19-20 year olds), are much less stable, because of the relatively small numbers of cases, and are therefore not displayed in the graphs.

Figure 2 shows the means for another indicator of alcohol use, the measure of occasions of heavy drinking (that is, having five or more drinks in a row in the past 2 weeks, measured on a scale from 1 to 6); the vertical scale is again approximately one standard deviation (1.4 units). The

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9. Note that this is not quite the same as no change in minimum drinking age; if a state raised its minimum drinking age from 19 to 20, that would not lead to a different position on the 3-category measure.

six-year averages are 1.973 for the age-18 states and 1.859 for the age-21 states; this difference is about 8% of a standard deviation.

Prevalences (that is, the proportions or percentages who report any occurrence of the behavior in the specified time period) are somewhat more readily interpreted than the mean values, and these are displayed in Figures 4 and 5 for the two measures of alcohol use. Monthly prevalence of alcohol use for the states with 18 as the minimum drinking age averages 72.9% across the six years, versus 67.0% for the age-21 states (Figure 4). Thus, the lower age limit seems associated with a monthly prevalence about 9% higher than in the age-21 states (calculated as (72.9% – 67.0%)/67.0%). The two-week prevalence of occasional heavy drinking (that is, drinking five or more drinks in a row on at least one occasion in the past 2 weeks) averages 41.3% versus 36.7% (Figure 5), or about 13% more for this measure of occasional heavy drinking. Note that on the more sensitive measure (mean), the difference is less for the measure of heavier drinking than for the monthly measure, while the reverse is true for the dichotomous prevalence measures. Consequently, it is difficult to conclude that the minimum drinking age affects one of these types of drinking more or less than the other. Perhaps the most valid and important conclusion to be drawn is that during the years 1976 to 1981 *alcohol use was clearly higher, by a factor of about 11%, plus or minus 3%, in states with a minimum drinking age of 18 compared to states with a minimum drinking age of 21.*

These analyses, as displayed in Figures 1 through 4 (and tabulated in Appendix A, Table A-2) appear to demonstrate clearly that there are in fact differences in drinking behavior associated with minimum drinking age differences. Before turning to the question of whether there appear to be other variables that might help explain or attenuate the differences, we first look at overall trends in alcohol use in the entire 1976 to 1987 period, as related to minimum drinking age. One important issue to be addressed is whether overall trends in alcohol use during this period seem attributable to the changing minimum drinking ages. This issue is relevant because a gradual decline in alcohol use was observed among high school seniors nationally between 1980 and 1987 (Johnston, O'Malley, & Bachman, 1988, p. 10), and a natural question was whether the decline was attributable to the changes in minimum drinking age laws. We turn now to analyses that address this question.

Minimum Drinking Age Differences: 1976-1987

A different approach was necessary to look at the pattern of alcohol use across the broader study interval of 1976 to 1987. Instead of limiting the interval in order to incorporate states with no change in their minimum drinking age, all states were included. One useful way to group states was to categorize them according to their recent history of minimum drinking age law. The categorization resulted in two conceptually important groups of states: (a) states that changed from 18 to 21 during the 1976-1987 interval — an alternative way of stating the criterion for inclusion in this category is that it includes all states that allowed purchase of at least some form of beverage alcohol at age 18 at some point in the 1976-1987 interval; and (b) states with a minimum age of 21 throughout. The number of cases available for the "18 at some time" group never dips below 8,500 cases in a year, and the "constant 21" group never dips below 4,000. The residual category, all others (most of these were states that changed from 19 or 20 for some alcohol to 21), is very small, with as few as 1,220 cases in a year; consequently, the data for the "all others" category are understandably unstable and are therefore not displayed in the graph. (Table A-3 in Appendix A provides all the data.)

Figure 5 displays the means for the measure of 30-day use; the vertical scale is again approximately one standard deviation. Figure 6 shows the corresponding data for the measure of occasional heavy drinking, and Figures 7 and 8 show the prevalences. From these data (and from the earlier data as well), one can see clearly that in the mid- and late-1970s and the very early 1980s there was a difference between the states with a minimum drinking age of 18 at some time and the constant 21 states. That time period (1976 to 1981 or so) corresponds to the time when the minimum drinking age of 18 would have been in effect (as seen previously). Since then, virtually all of those states have raised their minimum drinking age to 21. And corresponding (roughly) to that change, the difference between the two groups of states has been essentially eliminated. This provides additional evidence that the minimum drinking age does have an effect on the frequency of drinking by high school seniors. Note for example that there is a distinctly higher (though certainly not massively higher) rate of drinking in 1979 among the schools located in states that had a minimum drinking age of 18 at some time, compared to the schools in the constant-21 states. In 1986, this difference has all but disappeared. Because *exactly the same states* are involved in both years, the difference is highly unlikely to be due to other "cultural" factors that happen to be reflected in differences in minimum drinking ages.

The data displayed in Figures 5 through 8 show that the time trends in alcohol use in the constant-21 states are not simple, and that overall trends in alcohol use have varied in ways that cannot be attributed entirely to changes in minimum drinking age. There seems to have been a slight rise in the late 1970s through 1981, then a gradual decline in the early 1980s, followed by a stabilization in the period from 1985 to 1987. These figures make it clear that *the overall declines in alcohol use that were observed in the early to mid-1980s were not solely attributable to changes in state minimum drinking age.* In particular, the fact that there were substantial declines in the constant-21 states refutes that possibility. It is also the case however that *some of the overall decline appears due to the effect of changes in the laws, because the states that increased their minimum drinking ages showed larger declines.*

Multivariate Controls

It might reasonably be pointed out that the various cross-sectional differences observed between states with varying minimum drinking ages, especially as indicated in Figures 1, 2, and 3 are confounded by differential population characteristics, and that variations in minimum drinking age could merely reflect these more fundamental differences. For example, states with high levels of religiosity, on average, might be more inclined to prohibit alcohol to younger individuals, and the level of religiosity may be the more important determinant of teen-agers' drinking. The data in Figures 4, 5, and 6 argue against this position, because the same states are involved and the differences in alcohol use have been diminished following changes in states laws; presumably changes in state minimum drinking age laws that were imposed by federal action would not result in changes in more fundamental characteristics. Nevertheless, it may be useful to address the issue as to whether the law is an important determinant of behavior in another way, specifically, by controlling statistically for various individual level characteristics, including religiosity, truancy, race, sex, etc., to determine if minimum drinking age category still "explains" some variance. The results of such analyses indicate again that minimum drinking age laws do make a difference; even after controlling a number of relevant variables, the states with a low minimum drinking age of 18 show higher alcohol use. The effects are small, but the data are consistent.

The evidence for this is shown in Table 8, which displays the results of multiple linear regressions. For this phase of the analysis, a correlation matrix was computed, based on the data collected in 1976 through 1981 in those states that did not change their minimum drinking age laws throughout the period. The resulting number of cases is 71,319.[10] Because of the very large number of cases, almost all regression coefficients were significant at conventional significance levels.[11] The variables selected for controlling are known, based on previous research (Bachman et al., 1981), to be related to alcohol use. These include sex, race, college plans, number of parents in the household, average parental education, religious commitment, region of country, and urbanicity. The major finding can be stated very briefly: even after controlling for a number of important demographic factors, minimum drinking age remains a significant predictor — substantively, as well as statistically — of the various measures of alcohol use. The unstandardized regression coefficient predicting prevalence of 30-day alcohol use for individuals in a state with a minimum drinking age of 18 was .056. This can be interpreted as saying that there is a 5.6% higher prevalence (on an absolute scale) *even after controlling* all the listed factors. Similarly, the corresponding coefficient predicting prevalence of heavy drinking is .028, implying a 2.8% higher prevalence of that behavior, after controls. These effects are only very slightly — if at all — smaller than the zero-order effects (that is, the effects before controls for other factors). Table 8 provides additional figures for the interested reader, but the point seems clear. The zero-order minimum drinking age effect is not one that is easily explained by other factors.[12]

A similar analysis was conducted with respondents who completed the form that includes the specific alcohol beverages, that is, beer, wine, and liquor separately. As expected, these analyses showed that beer was the beverage most affected by the minimum drinking age laws; that is, it shows the most significant regression coefficient. Liquor consumption was also affected to a considerable degree, but wine consumption was not much affected at all.

Minimum Drinking Age Differences: Post High School

It is at least conceivable that minimum drinking ages affect the behavior of high school students more than they affect the behavior of older adolescents. In particular, some observers have indicated that alcohol use is so pervasive among college students that minimum drinking age laws would have very little effect on their drinking behaviors. Accordingly, a first look at the follow-up data involves college-age respondents. As reports from the Monitoring the Future project have indicated (Johnston et al., 1988), alcohol use is higher among college students than among other high school graduates of similar age not in college. (This contrasts with most illicit

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10. These data were weighted. Weights were used because it seems likely that the best estimates of individual level population correlations among the various control variables would be provided by the weighted data.

11. Using even a very large design effect of 11 — the maximum estimated value observed in an extensive set of calculations of design effects across a number of dependent variables — leaves more than 6,000 as the effective N.

12. Including a control for secular trend by adding dummy variables for year of administration in the regression equation did not alter the minimum drinking age regression coefficients more than trivially, and controlling for individual religious preference, in addition to religious commitment, also had virtually no effect on the regression coefficients.

drug use, which is lower among college students than among their age-mates not in college.) Most college students are eligible to purchase alcohol if the minimum drinking age is 18 or 19, but most are not eligible if the minimum drinking age is 21. Figure 9 displays alcohol use (mean 30-day use) for follow-up respondents who were college students as of 1 to 4 years after high school graduation. (College students are here defined as those respondents one to four years after high school graduation who report attending a 2- or 4-year college full-time in March of the survey year. These data are available only since 1980, when a minimum of four previous high school classes were first included in the follow-up surveys.) College students are divided into two groups: those who, as high school seniors, were residing in states with a minimum drinking age of 18 for at least some alcohol versus those residing in states with a minimum drinking age of 21.

As Figure 9 shows, college students who were high school seniors in states with a minimum drinking age of 18 do indeed drink more while in college than their counterparts who were high school seniors in states with a minimum drinking age of 21. Similarly, other graduates of the same age not attending college also drink more on average if they were seniors in a state with a minimum drinking age of 18 (Figure 10). Unfortunately, it is not possible to ascertain definitively where the follow-up respondents were residing in the interval for which they were reporting their alcohol use for the follow-up surveys prior to 1986. (And since that time, almost all states have a minimum drinking age of 21.) If we assume that the majority of respondents remain within their state of residence in high school, then the above comparisons seem reasonable to conduct. Some "noise" or error is introduced, but it is likely not a systematic bias. It is possible that a higher proportion of college students, as compared to noncollege students, were living in a different state than they were in as high schools seniors, but that should only dampen any differences by introducing more error. (We assume that choice of college is not much affected by the minimum drinking age of the states involved.) In any case, most of the differences have disappeared by 1986-87, when virtually all the states have a minimum drinking age of 21. (Tabular data are provided in Appendix A, Table A-4.)

An additional question of interest is whether the lower rates of drinking observed among high school seniors who reside in states with high minimum drinking age disappear when those individuals reach age 21. This question was addressed by conducting analyses parallel to the earlier cross-sectional analyses. Respondents from the classes of 1976 to 1981 were separated into two categories: (1) those who were residing in states with minimum drinking age of 18 throughout the period, and (2) those who were residing in states with minimum drinking age of 21 throughout; reports of alcohol use at ages 21 through 25 were compared for these two groups. The follow-up data were collected in 1979 through 1988. (In this case, unlike with the college-age respondents, it makes little difference where the respondents reside at follow-up, because all are enfranchised.)

Figure 11 displays the data for 30-day mean alcohol use; note that the horizontal axis is age at administration, as opposed to year of administration, which was used in previous figures. The data points for the 18-year olds are the means across all respondents in the combined classes of 1976-1981 measured in senior year of high school, separated according to state minimum drinking age as of base-year (age-18 states versus age-21 states). The data points for age 21 at administration are means across all follow-up respondents (separated by base-year minimum drinking age) from the classes of 1976-1981 participating 3 years after graduation; this would be in 1979 for the class of 1976, 1980 for the class of 1977, and so on. Figures 12, 13, and 14

provide similar data for the other measures. Perhaps surprisingly, the data show that there appears to be a lingering effect; even after everyone has achieved eligibility to purchase all types of beverage alcohol, those who were prevented by law from such purchase before age 21 appear to drink slightly less alcohol. (Respondents participating 3 years after graduation would include some who are not yet 21, but this is obviously not an important factor, as indicated in Figures 11 through 14.)

Incidentally, Figures 9, 10, and 11 indicate a decline in use with age after age 21 or 22. But there is a potential problem with this apparent effect: the age data are confounded by year (or by cohort). For example, the groups providing data at age 21 were followed-up in 1979 through 1984, whereas the groups providing data at age 25 were followed-up in 1983 through 1988. If use were lower in general in the later years of the 1979 to 1988 period, then one might expect to see a decline in use by age in Figures 9, 10, and 11, even if there were no real "age" effect. For present purposes, of course, we are not here trying to determine whether there is some age effect; instead, we are comparing two different groups of respondents from the same classes in the same year of data collection, and therefore, age effects are not a problem for present purposes. In other analyses, however, we have demonstrated by using more complete data that in fact there probably is a real age effect as suggested in Figures 9, 10, and 11 (O'Malley, Bachman, & Johnston, 1988).

A point to note in the data displayed for ages 21 through 25 is that we are dealing with much smaller numbers of cases here as compared to analyses of high school seniors; it is reassuring to see that the findings are consistent across the different classes and slightly different sets of states. (Weighted number of cases are all greater than 1,200; weighted numbers, and means and standard deviations, are provided in Appendix A, Table A-5).

Effects of Changes in Minimum Drinking Age Laws

In this next phase of analyses, we examined the effect of law changes in groups of states. Groups of states were necessary because the samples of schools in individual states did not provide sufficiently stable data to allow reasonably secure estimates. These analyses have several aspects. First there is the basic, zero-order difference, a comparison of alcohol use in the same states before and after minimum drinking age law changes. Then we incorporated adjustments, first for secular trend and second for other potential confounding variables.

Perhaps we should make very clear that we are not asserting that we have a rigorously representative sample within each of the states involved in law changes. The base-year samples are drawn so as to be nationally representative, including all geographic regions, levels of urbanicity, types of schools, and so on; more precisely, the design is such that the base-year samples are representative of each of the four geographic regions (Northeast, North Central, West, and South). While it is not the case that the sample in any one state is necessarily representative of that state, it is the case that as one aggregates or collapses across states, one approaches a representative sample for the aggregate set of states. Thus, for example, we believe that data aggregated across all states with an unchanged minimum age of 21 fairly accurately represent all seniors who live in states with a consistent minimum drinking age of 21. Similarly, there are data from 21 states that increased their minimum drinking age from 18 to 19, 20, or 21. In the aggregate, this should be a reasonably good sample from which to draw inferences about the effect that those increases have had.

There are several ways to approach the issue of effects of a change in the minimum drinking age. Theoretically, we could examine 6 distinct groups of change states (insofar as possible), and compare their rates of alcohol use by high school seniors before and after the change. The groups were states changing the minimum drinking age from (1) 18 to 19; (2) 18 to 20; (3) 18 to 21; (4) 19 to 20; (5) 19 to 21; and (6) 20 to 21. By grouping states within each category, we could check whether certain changes seemed more important than others. After some inspection of the data it seemed clear that there were in fact shifts in alcohol use associated with law changes. Because some of these law changes were relatively recent (and thus there were not many years of data after the change) and others were relatively early (and therefore there were relatively few years before the change), a period of 3 years before and 3 years after has been chosen for presentation and discussion. Although the amount of shift in use did vary somewhat by type of change, there seemed consistently to be declines in use following changes. We do not provide all the detail here. Instead we report the data for combinations of states; one combination includes all states that raised their minimum drinking age, regardless of the specific ages involved, and another combination includes only the states that changed from a minimum drinking age of 18 to a higher age (19, 20, or 21). The latter should be particularly important for high school seniors, most of whom are under 19.

Grandfather clauses complicate any interpretation of these analyses; still, by grouping several years prior to the change and looking at differences a year or more subsequent to the change, any important reasonably immediate effects should be evident. In the absence of any immediate effect, there is an alternative explanation that drinking patterns could have been established well before the end of senior year, and thus the effects of changed laws would not show up in senior classes until some years later. The fact that we did observe immediate effects alleviates this potential problem.

Comparison of Use Before and After Change

Changes in minimum drinking age from 18 to 19, 20 or 21. Figures 15, 16, 17, and 18 present the data for three years before and after a change in the minimum drinking age from 18 to a higher age (19, 20, or 21) for four measures of recent drinking. Figure 15 shows the data for mean 30-day alcohol use, again with the vertical scale representing about one standard deviation. Combined across all states that increased the minimum drinking age from 18 (to 19, 20, or 21), there was a 13.3% decrease (expressed as a percent of the total standard deviation) in mean drinking in the past 30 days. For the measure of heavy drinking, the decline was 8.9% of a standard deviation (Figure 16). There were declines in prevalences of these behaviors of 6.6% and 8.5%, respectively, expressed as percent of before-change prevalence (Figures 17, 18). Although these effects are not massive, they are substantial, and certainly in the direction hoped for by proponents of higher minimum drinking ages. It is also of interest that the decrease appeared immediately after the change in law, with very slight additional decreases in the succeeding two years. (Each data point in Figures 15, 16, 17, and 18 is based on at least 7,300 seniors in at least 49 schools; Tables A-6a and A-6b in Appendix A provide the numbers.)

For those who questioned whether a change specifically from a minimum drinking age of 18 to 21 would have any important effect, the data are very clear. There was a decline of 28.2% of a standard deviation in alcohol use (in the case of the 30-day frequency measure) — certainly an important effect, and a decrease in prevalence of occasional heavy drinking from 46.0% to

36.7% is surely also important. (For analyses of the effect of the 18 to 21 change, the minimum number of seniors per year was 950.)

Changes in minimum drinking age from 19 to 20, 19 to 21, and from 20 to 21. There are relatively few cases with states changing from 19 to 20 (1,220 total cases in the three years before change and 2,100 in the three years after change) and from 20 to 21 (3,800 before and 2,800 cases after); there are more cases in states changing from 19 to 21 (17,000 before cases and 13,000 after cases). In the latter group — the 19 to 21 change— there was a decrease in alcohol use in the first three years after the change, as there was with the change from 18 to 21. Compared to the three preceding years, mean 30-day use was down 5.5% of a standard deviation, and mean occasions of heavy drinking was down 2.6% of a standard deviation. Prevalence declines were 3.3% and 4.1% respectively (as a percent of initial prevalence). Thus, the effects of a change in minimum drinking age from 19 to 21 on high school seniors were modest, more modest than in the case of changes that disenfranchise 18-year olds. But this pattern does not seem unreasonable. For the 19-to-20 and the 20-to-21 changes, mean alcohol use was also lower in the three years after change compared to the three years before the change, but the small numbers of schools make these shifts much more variable from year to year. In fact, for the 19 to 20 change group, the difference between the 3-years before and after were not statistically reliable (even with no design effect incorporated). For the 20 to 21 change, the overall mean declines were statistically reliable, but the year-to-year data were very variable, suggesting rather little systematic effect of a law change on high school seniors.

Adjusting For Secular Trends

With respect to the secular trend, the problem is this: there seems to have been a general upward trend in alcohol use during the late 1970s, judging from the data from states with a constant minimum drinking age of 21, and a downward trend in the early 1980s. Similar trends in alcohol use in states with changes in minimum drinking age laws during those intervals might suggest an artifactual effect of law changes. One simple way to control for the general trends in alcohol use is to assume that the major societal trends in alcohol use are reflected in the states with a constant minimum drinking age of 21. Then, we compare the trends in the law-change states for the relevant years relative to the group of states with a constant age of 21. If there is an effect of law change, there should be differential trends in the law-change states, either more decline or less increase.

The specific procedure used was simply to subtract out the mean alcohol use (for the relevant measure) of all constant-21 states for the relevant years. In other words, there would have to be a difference following a change in minimum drinking age *larger* than observed within the constant-21 states for the minimum drinking age change to be considered a causative factor. Similarly, states changing at other times would also have their effects looked at relative to other nonchanging constant-21 states. The result of these analyses (not shown) indicated quite clearly that secular trends did not affect the law change results; the adjusted and unadjusted trends were very similar and virtually indistinguishable in shape.

In addition to general secular trends in alcohol use there is the potential of trends in other variables spuriously associated with any change in minimum drinking age laws. For example, if, by chance, schools in the "after" years were higher in the percentage of seniors expecting to attend college compared to the "before" years, that would likely lead to lower rates of alcohol

use (because college-bound seniors drink less while in high school than non-college bound seniors). To address this question — at least to some extent — multiple linear regressions were performed, using the set of individual-level variables known to correlate with alcohol use (sex, race, number of parents in household, average parental education, region, urbanicity, college plans, and religious commitment), plus a variable indicating the before-after status of the state with respect to changed minimum drinking ages. If there were shifts in the individual-level variables associated with the changes in minimum drinking ages then the regression coefficients capturing the link between change and alcohol use would be attenuated. In fact, the standardized regression coefficients were virtually equal to the zero-order correlations.

Differential Effects on Subgroups

One of the areas that the present research design was uniquely able to address is that of differential effects of minimum drinking age changes on different strata of seniors. For example, one might hypothesize that minimum drinking age laws would have stronger effects on rural high school students compared to urban students, perhaps because of the greater number of alcohol outlets more readily available in urban settings. We examined the trends in alcohol use behavior for selected subgroups over time, in order to gain a clearer understanding of the nature of differences. Subgroups were stratified on the basis of sex (male, female); race (white, black); college plans (yes, no); religious commitment (low, high); and urbanicity (Large SMSA, Other SMSA, NonSMSA). The findings were generally as one would expect, if one assumed that minimum drinking age effects would be fairly well distributed throughout the population of high school students; that is, the size of the effects would be proportional to the amount of use before the minimum drinking age increase. Thus, for example, white seniors report much more alcohol use than black seniors, so minimum drinking law changes should — and do — show larger effects for white seniors; similarly, seniors reporting a low degree of religious commitment showed more of a decrease in alcohol use after the increased minimum drinking age compared to those reporting a high degree of commitment. Table 9 indicates the percent of a standard deviation difference in 30-day mean frequency of drinking for the three years before and after a minimum drinking age increase from 18 to any higher age for the various subgroups. Overall, the differences between subgroups are really quite modest in size; there do not appear to be any major differences by subgroup beyond that which would be expected on the basis of amount of use.

Law Change Effects on Variables Other Than Alcohol Use

This research was equipped to explore a broad array of measures other than just recent alcohol consumption. More specifically, there are measures available on: (a) driving violations and traffic crashes following use of alcohol; (b) circumstances or setting of alcohol use; (c) reasons for drinking; (d) degree and duration of intoxication; (e) attitudes toward drinking; (f) use of other psychoactive substances; (g) delinquent behaviors and victimization experiences; (h) truancy; and (i) grade of first use of alcohol. These other measures were examined in a similar fashion as above, with analyses restricted to states that changed their laws from 18 to some higher age, and to the 3-year periods immediately before and after the change. We will also comment selectively on the differences observed cross-sectionally in the 1976 to 1981 interval.

Driving violations and crashes. Following the increase in minimum drinking age from age 18 to some higher age, high school seniors report no significant shift in number of moving violations.

There was a decline in the number of such violations that involved alcohol use, but the decline was not significant in the total set of states changing from age 18 to a higher age. There was, however, a significant decline in those states that changed the minimum age from 18 to 21. In terms of crashes, there were only very slight declines, both in all the states that increased the minimum drinking age from 18, and in just those states that increased from 18 to 21. Crashes following alcohol use declined but not significantly. In other words, although the frequency of *fatal* alcohol-involved crashes generally declined among the 18-20 age group subsequent to increases in the minimum drinking age, according to the literature reviewed above, the self-report data here do not show major declines in crashes involving alcohol for high school seniors. However, the changes are all in the expected direction.

Looking at the cross-sectional data for the 1976-1981 interval, we can compare self-reported violations and crash involvement by minimum drinking age category. There was a small difference in the mean number of violations, with seniors in the 21-age states reporting slightly more violations (by 7% of a standard deviation). However, among those who received a moving violation, there was a very slightly higher mean frequency of such violations occuring after alcohol use in the 18-age states. Seniors in the 18-age states also reported a very slightly higher mean number of crashes, compared to those in the 21-age states, and they also reported more alcohol-related crashes (by 4% of a standard deviation).

Thus the evidence is fairly consistent in showing more alcohol-related traffic mishaps among the 18-age states compared to 21-age states, both cross-sectionally and dynamically, although the differences are not very great.

Circumstances or settings of alcohol use. Respondents were asked how often they used alcohol during the past year in certain settings, for example, when they were alone, at home, at school, etc. None of these settings showed a significant shift following the law change. One particularly interesting setting asked about is drinking in cars. Some observers have been concerned that increasing the minimum drinking age might lead to some displacement of drinking by under-age people from more public places such as bars or taverns to more private places like cars. But the data show no evidence at all for an increase in the frequency of drinking in cars; there was in fact a very slight decrease (4% of a standard deviation) observed in the 3 years after 18-year olds were disenfranchised compared to the three prior years. One behavior related to alcohol use did show a dramatic effect: the frequency of going to bars or taverns decreased sharply (by 31% of a standard deviation). The conclusion to be drawn seems clear: high school seniors drink more in bars and taverns when that option is legally available. They drink much less in bars and taverns when they are not enfranchised. (We will say more about this later.)

Reasons for drinking. Respondents were also asked their reasons for drinking. Only one of a number of reasons for drinking shifted significantly — more respondents reported drinking "To get away from my problems or troubles." However, this shift was small and possibly due in part to a general secular trend. Moreover, the cross-sectional difference in 1976 through 1981 showed essentially no difference on this measure between the age-18 and age-21 states. The overall pattern of data suggests that a change in minimum drinking age does not substantially affect seniors' reasons for drinking.

Degree and duration of intoxication. One putative effect of a lower minimum drinking age has been that young drinkers learn to drink more responsibly. Perhaps, therefore, a higher drinking

age could lead to more intoxication among under-age drinkers when they do drink. Based on seniors' self-reports as to how high they usually get and how long they usually stay high when they drink alcohol, there is no effect at all of minimum drinking age — there was essentially no shift following an increased minimum age. (Eta values comparing the means for 3-years before and 3-years after are .004 and .002.[13]) A related question asks about the proportion of drinking occasions on which the respondent gets "pretty high"; this measure also showed no difference between states with a low minimum drinking age compared to states with a high minimum drinking age (cross-sectionally).

Attitudes toward drinking. Behaviors and attitudes are often assumed to be related; therefore, one might ask whether, if shifts in behavior are observed, attitudes show shifts as well. Two particular attitudes (or beliefs) about alcohol use were assessed. One is the perceived risk of harm associated with various patterns of use, and the second is the respondent's own disapproval of use. The patterns of use asked about are: (a) trying one or two drinks, (b) taking one or two drinks nearly every day, (c) taking four or five drinks nearly every day, and (d) having five or more drinks once or twice each weekend. Consistent with the decline in use observed among seniors following an increase in minimum drinking age, the perceived risk of harm increased, for all patterns of alcohol use. The magnitudes of the increases were 6-12% of a standard deviation, depending on the particular pattern of use. Seniors' own disapproval increased by about 6% of a standard deviation for each of the patterns. Similar questions were asked about seniors' perceptions of their friends' disapproval of alcohol use. These might also be expected to show some effect of a minimum drinking age change, and they in fact did show effects, in a range commensurate to those for the seniors' own attitudes. Perceived friends' disapproval of various patterns of alcohol use increased somewhat, by 6-12% of a standard deviation, depending on the particular pattern of alcohol use. (Friends' use also declined: seniors reported that the proportion of their friends who drink or get drunk at least once a week each declined by about 3% of a standard deviation.)

Use of other psychoactive substances. One possible effect of an increased minimum drinking age feared by some was a shift in use from alcohol to other psychoactive substances, particularly marijuana. In fact, we observed a decline in mean 30-day marijuana use following the increased minimum drinking age; the decline was 11% of a standard deviation. Much, but not all, of this decline can be attributed to the secular trend for marijuana, which declined in prevalence throughout the 1980s. But even after subtracting out the decline (based on the data from the constant-21 states), there is a decrease in marijuana use following the law change.

This decrease is not inconsistent with another possible indirect effect of a higher minimum drinking age, that is, a decrease in use of illicit substances. To the extent that alcohol functions as a gateway drug, one that facilitates use of other psychoactive substances, a decline in alcohol use should produce less use of other psychoactive substances such as marijuana. Because of the general declining use of marijuana and most other illicit substances throughout the 1980s, it would be difficult to assert a causal connection with the decrease in alcohol use. But it does

13. The eta statistic is a measure of the proportion of variance in the dependent variable that is explained by a categorical independent variable. A value of .004 indicates that 0.4% of the variance in the dependent variable is explained by the two-category variable comparing the means before and after the law change.

seem very clear that there was no increase in use of illicit drugs coincident with the decline in alcohol use.

Delinquent behavior and victimization. Self-reported frequency of various types of delinquent behavior showed essentially no difference after the minimum drinking age change compared to before the change. (There were 13 separate items asking about delinquent behaviors. Seven had an adjusted eta of 0.0; of the six with non-zero adjusted etas — all less than .015 — three increased in frequency and three decreased.) A related phenomenon — victimization, or being a victim of delinquent behavior by someone else — also showed essentially no effect of a minimum age change. (Six different items were included; five of the six had an adjusted eta of 0.0, and the other adjusted eta was 0.004.)

Truancy. An index of truant behavior — skipping classes or whole days of school — did show a decline following the increase in minimum drinking age, a decline of about 10% of a standard deviation. Inasmuch as drinking in school was not affected by the increases in minimum drinking age, and delinquent behavior generally was not affected, it is not clear why truancy should show an effect. (Truancy rates in the unchanged states did not decline as much.) Cross-sectionally, a similar relationship was observed. That is, during the 1976-1981 period, truancy rates were distinctly higher in age-18 states than in age-21 states (by 16% of a standard deviation). The fact that there was such a difference cross-sectionally, combined with the shift observed following law changes, suggests a real effect.

Age of onset of alcohol use. There was a slight *decrease* in the average age of onset after the increase in the minimum drinking age, a direction that is not consonant with increased drinking by younger adolescents when there is a lower minimum drinking age. Three years may not be a long enough time period for an effect on age of onset to be manifested, but comparisons of cross-sectional differences (instead of before-after comparisons) also fail to show an earlier age of onset. For example, in the 1976-1981 interval there was a nonsignificantly higher age of onset among the states that permitted 18-year olds to drink compared to states that required age 21, and the same is true for the shorter 1979-1981 interval. This latter interval, 1979-1981, is particularly important because by then, most states with a low minimum drinking age had permitted 18-year olds to drink for a number of prior years. Eleven of the 16 age-18 states that provided data in the 1979-1981 period had permitted alcohol purchase by 18-year olds as far back as 1969, and the other 5 had permitted such purchase at least as early as 1974 (Bonnie, 1985).

Analyses Linked To Official Statistics

A separate portion of this research effort was a coordinated analysis of official statistics on fatal automobile crashes, using the Fatal Accident Reporting System (FARS). In the next set of analyses of the self-report data, we looked, as did the FARS analyses, at a subset of states that provided crash data for three years before and after a change. Thirteen states met this requirement: Delaware, Florida, Georgia, Illinois, Maryland, Massachusetts, Michigan, Nebraska, New Jersey, Ohio, Oklahoma, Tennessee, and Texas. The aim of this phase is to compare the findings from the FARS analyses with self-report data for the same states. This comparison of data from two entirely separate sources of data is an unusual feature of the present research. An important question that can be answered in the current study is whether that decline

may be attributed to less use of alcohol among high school seniors. There are other alternative possibilities, for example, that use is simply displaced but not lessened. In order to answer this question, we compare self-report data for three years before and after the increase in minimum drinking age for those states used in the FARS analysis. We begin by briefly summarizing the results of the FARS time-series analyses. (More details are included in Appendix C.)

Effects of law changes on fatal crashes are shown in terms of frequencies (unadjusted numbers of fatal crashes) and rates (numbers of fatal crashes, adjusted for the relevant number of drivers). The rate is the more appropriate measure, and it is the one that will be discussed. Table 10 provides estimated effects on rates for four categories of crashes: (1) the most important category for present purposes is single-vehicle nighttime crashes involving a driver less than 21 years old (LT21SVN); (2) single-vehicle nighttime crashes involving a driver 21 years old or older; (3) daytime crashes involving a driver less than 21 years old; (4) daytime crashes involving a driver 21 years old or older. Because the involvement of alcohol in motor vehicle crashes is very difficult to measure, and because its measurement is highly variable over time and across jurisdictions, single-vehicle nighttime crashes are used as an indicator for alcohol-related crashes. (See Wagenaar, 1983, page 42-43 for more extensive discussion of this point.) Multiple categories were examined to increase confidence that observed changes in fatalities were due to changes in minimum drinking age laws, and not to other coincidental factors. Changes in fatalities attributable to law changes should be seen only in single-vehicle nighttime crashes involving drivers in age groups affected by the laws. Similar changes were not expected in other groups because none of the laws affected legal access to alcohol for those age 21 and over, and because alcohol involvement is significantly less prevalent in daytime crashes.

The principal finding, as shown in Table 10, is that there was a decline in single-vehicle nighttime fatal automobile crashes among drivers less than 21 years of age (LT21SVN), following an increase in minimum drinking age. In each of the several (not all mutually exclusive) categories of change, the rate of LT21SVN fatal crashes declined significantly. The largest rate change occurred among the states whose change in minimum drinking age was three years (that is, from 18 to 21); in these states, there was a decline of 26.3% in the rate per licensed driver of alcohol-involved single-vehicle nighttime fatal crashes involving drivers under 21 (and 27.8% in the frequency of such crashes), comparing the three years before and the three years after a law change, as estimated by the time-series analyses. But states with a two-year change (from 18 to 20 or from 19 to 21), and states with a one-year change (from 18 to 19, or from 19 to 20, or from 20 to 21) also showed significant declines in crash rates, of –18.6% and –21.6%, respectively. For single-vehicle nighttime crashes involving drivers 21 and older, the estimated declines were smaller: 17.7% (in rate) for the three-year change states, and 9.9% for the two-year states. There was no significant change in crash rate for the one-year states. Thus, the law change appears to have affected the under-21 drivers specifically. Aggregated across the several states (ignoring distinctions as to type of minimum drinking age change, as well as whether there was a grandfather clause), there was a decline of 15.4% in fatal crash rates involving drivers under 21 compared to a decline of only 5.4% involving drivers 21 and older. Whether a minimum drinking age change was grandfathered or not seemed to make relatively little difference: LT21SVN crashes declined slightly less in the states without a grandfather clause (-20.0%) compared to those states with a grandfather clause (23.9%). This difference is opposite what one might expect if grandfather clauses were important.

Figure 19 provides a graphical display of just the under-21 single-vehicle nighttime crash rates, showing the percent shift in rate of fatal crashes as a function of the several different types of changes. There were statistically significant (and in this case certainly substantively significant) declines in the rate of these crashes in each type of change category, with the largest decline in the 3-year change category. Figure 20 again shows the percent decline in the rate of single-vehicle nighttime fatal crashes involving drivers under age 21, and adds the decline in self-reported mean frequency of 30-day alcohol use (expressed as a percent of a standard deviation) among high school seniors surveyed in the same states, in the same years; Tables A-7a and A-7b in Appendix A provide the numbers. There was an evident decline in self-reported mean alcohol use during the same time period in the same states. The aggregate decline between the three-year before versus three-year after is 13.8% of a standard deviation, as compared to 15.4% for rate of LT21SVN crashes. These self-report data therefore support the notion that the decline in single-vehicle nighttime crashes following increases in minimum drinking ages are a direct result of lowered amounts of alcohol consumption. The declines in both variables (crashes and self-reported use) are greatest for the 3-year changes (from a minimum drinking age of 18 to 21), which is entirely reasonable. However, the self-report data indicate that the declines were distinctly smaller for the 1-year and 2-year changes; the FARS data do not show correspondingly large differentials. The self-report data also show a stronger effect in the states without a grandfather clause, as compared to the states with a grandfather clause. The FARS data show the opposite, a stronger effect in the grandfathered states. The self-report data seem more plausible; the less plausible findings for the FARS data is very likely due to the fact that fatal crashes are a very rare occurrence and the attendant high stochastic variance makes it is much more difficult to discern differential patterns (particularly in small groups of states).

The mean frequency of self-reported tickets and crashes decreased in the states involved in this phase of the analyses, but only very slightly. The mean number of self-reported crashes decreased from .360 to .325 (measured on a scale of 0 to 4, where 4 is four or more; the decrease is 5% of a standard deviation). The mean number of those crashes that occurred after the driver had been drinking decreased from .166 to .163. The latter figure of .163 is 50% of .325 (on average, half of the crashes involved occurred after the driver had been drinking), up just slightly from 46% (.163/.360). Thus, the self-report data on crashes involving high school seniors coincide with the official statistics in showing a decline in crashes and in the number of crashes involving alcohol. However, the declines are not as great as those observed in alcohol use.

In addition to the lower amount of alcohol use, there is considerably less going to bars or taverns by high school seniors following an increase in minimum drinking age. It therefore seems plausible that drinking in bars contributes disproportionately to involvement in automobile crashes. One reason for this disproportionate involvement may have to do with the fact that there is generally a very specific time for terminating serving alcohol in bars. This leads to many individuals having one or more drinks — literally "for the road" — just before closing; consequently, just after closing, many of these same individuals converge on the highways.

In order to rule out other potential explanations for the decline in driving crashes following an increase in minimum drinking age, we conducted multivariate analyses utilizing the self-report data. If for example, the amount of miles driven per week were to decline after minimum drinking age law changes (for reasons not causally related to the law change), that might account for the decline in crashes. Even after controlling (via multiple linear regression) for a number of other variables (including sex, race, number of parents in the home, parental education, college

plans, religious commitment, truancy, number of evenings out per week, and weekly income, in addition to number of miles driven per week), a significant effect of minimum drinking age remained.

Discussion and Conclusions

What can we conclude from the results of the various analyses described above? Perhaps the principal conclusion is that a minimum drinking age of 21 versus a minimum drinking age of 18 does indeed affect the behavior of high school seniors; it leads to lower consumption of alcohol. The several studies cited earlier (page 5) have demonstrated rather conclusively that alcohol-involved highway crashes decline among the 18- to 20-year old population, and the present research makes it clear that the decline is directly due to lower levels of consumption. And it also seems clear that a major factor in the reduced rate of crashes is that the under-21 group spend less time in bars and taverns when the minimum drinking age is 21. Another contribution of the present research is that the lower rates of drinking appear to be continued as young adults mature, at least through the early twenties. Thus, the lowered rates of drinking in the 18-20 age range are not compensated for by a higher rate of drinking after enfranchisement is achieved.

Generally, behaviors other than alcohol use are not so directly affected by the minimum drinking age. Delinquency seems not to vary by minimum drinking age. Nor does it appear that the degree or duration of intoxication varies. On the other hand, truancy does seem altered in a direction consistent with less drinking. Attitudes toward drinking are very modestly altered in a direction consistent with behavior — that is, seniors are slightly more disapproving and they perceive their friends as being more disapproving of alcohol use when the minimum drinking age is increased.

As with all social science research in a real-life, nonlaboratory situation, it is always difficult to make causal inferences. Whenever an effect is claimed, it is necessary to rule out alternative explanations. The most common alternative explanation for cross-sectional differences in behavior such as drinking by high school seniors associated with different minimum ages is that states with differing ages also differ on other factors. On a similar issue, for example, Bentler (1983) cites California as being reputed to have less traditional standards of religion (among other things), and he notes that this difference could serve as a competing explanation for differences in marijuana use that might otherwise be attributed to differences in the legal status of marijuana. In a more relevant instance, Grossman, Coate, and Arluck (1987) reported that consumption of beer by youth was negatively associated with prices for beer; but an alternative explanation to price having a causal effect was that areas with a general anti-alcohol sentiment would tend to enact higher taxes, resulting in higher prices. It could be argued that the general sentiment is the more important factor. And indeed, when Coate and Grossman (1988) introduced controls for one indicator of anti-alcohol sentiment (religious preference), the regression coefficient from price to beer consumption became nonsignificant. On the other hand, however, the regression coefficient linking minimum age to consumption remained significant.

In the present research, the cross-sectional analyses showed a significant coefficient even after controlling a number of important individual level factors associated with alcohol use. If youngsters in certain areas tended to drink less because there were higher levels of "community

religiosity" or some other indicator of anti-alcohol sentiment, these would presumably be captured by individual level variables that would serve as indicators of commitment to societal institutions. The introduction of variables such as religious commitment and grades should, if minimum drinking age effects were spurious, lead to less significant values for the relevant regression coefficients. But there were essentially no differences between the bivariate and multivariate associations. The most parsimonious explanation remains the most obvious one: minimum drinking age laws do have an effect on behavior. The effect is not very large, but there is no reason to expect any one variable to have a large effect on any social behavior.

As with the cross-sectional analyses, problems occur in interpreting any differences that may appear attributable to changes in minimum drinking ages. Douglass (1980b) cogently pointed out some of the problems that interfere with drawing inferences in "natural experiments" related to alcohol. In Michigan, after the minimum drinking age was lowered in 1971, other law-changes increased the *availability* of alcohol (by permitting Sunday sales, increasing the number of outlets, and liberalizing license status of taverns). Thus, any change in behavior could be ascribed to either the change in minimum age or to other changes in availability. Furthermore, Michigan later raised the minimum age back to 21, but at the same time, a law was passed requiring a cash deposit for all beer containers, which had the effect of raising the price of beer. Again, effects of the change in age on alcohol consumption patterns were confounded with another change, making inferences of causal effects extremely difficult.

In a related vein, Robert Straus has observed:

> I have been a bit concerned with the extent to which we may apply rather simplistic explanations to the apparent rise in problems due to the change in drinking age, without 'aking into account about six other things that were happening in society at the same time, such as the generalized increase in consumption of alcohol, the increase in use of a whole variety of substances by younger people, the enormous increase in the number of vehicles licensed to and driven by younger people, and several others. (1984, p. 130)

Straus's concerns were that problematic outcomes might have been misattributed to a decrease in minimum drinking ages, whereas we are more concerned about misattributing outcomes to an increase in minimum ages. A particular strength of the present analyses is that it was possible to control statistically, at the individual level, such extraneous factors as use of other substances or amount of driving were ould be statistically controlled at the individual level, to see whether variations associated with changes in minimum drinking age laws remain. As we have seen, those variations do indeed remain. Also of considerable importance in drawing causal inferences is the fact that many of the states changed their laws in response to external forces, in this case by federal action. The law changes were therefore not merely indicators of existing cultural sentiment, nor would they be expected to bring about shifts in other variables like religiosity or anti-alcohol attitudes. The clear effects observed in a variety of states are very unlikely to be due to extraneous factors.

We have also demonstrated that lower single-vehicle nighttime crash rates are associated with lower rates of alcohol use and lower amounts of time spent in bars and taverns in the same states in the same time periods before and after law changes. And other variables (delinquency, for example) did not show these variations. The research of O'Donnell (1985) is important in

emphasizing the significance of drinking in bars and taverns; in her review of the limited literature available, she found that the "results suggest that approximately half of the intoxicated drivers on our highways drink at licensed premises, especially bars, before driving" (p. 516).

Although the empirical data seem clear in showing a salutary effect of a high minimum drinking age, it can be argued on other grounds that minimum drinking ages should not be set at 21 when so many other "adult" roles can be assumed at age 18. On the surface, it seems unfair to many observers to allow 18-20 year olds to marry, to have children, to own cars and homes and firearms, to be financially and socially independent, and yet to be legally prohibited from drinking a glass of wine in a restaurant, or even a glass of champagne at their own wedding. A number of observers have worried about the effect this seemingly inconsistent situation may have. By stretching out adolescence (that is, by holding back the time when full adulthood is achieved), are we creating other problems? These issues may continue to be debated. The contribution of the present research is to demonstrate that whatever one wishes to make of other factors, there is a clear specific effect of a higher minimum drinking age: there is less drinking and consequently fewer fatalities. The effects are modest; nevertheless, modest differences in rates of drinking can be very important, particularly when those differences lead to lowered rates of fatal crashes. However, it should also be remembered that drinking remains a popular activity among high school seniors, even when the minimum drinking age is 21.

The popularity of drinking among seniors is not surprising. Alcohol use is a very common social practice among adults, particularly among young adults, and that alone would tend to make it an attractive activity for adolescents. And enforcement of minimum drinking age laws tends to be lax in most states. In addition, the use of alcohol is heavily promoted and glamorized in commercials; the entire aura around those commercials is pleasurable, athletic, sexual, fun — all the things that appeal to youth. Consequently, many more societal changes are needed in addition to changes in minimum drinking age laws if drinking among high school seniors is to be further reduced.

References

Abelson, H.I., Fishburne, P.M., & Cisin, I.H. (1977). *The National Survey on Drug Abuse: 1977.* Washington, D.C.: National Institute on Drug Abuse.

Bachman, J.G., & Johnston, L.D. (1978). *The Monitoring the Future project: Design and procedures.* (Monitoring the Future Occasional Paper No. 1) Ann Arbor: Institute for Social Research.

Bachman, J.G., Johnston, L.D., & O'Malley, P.M. (1981). Smoking, drinking, and drug use among American high school students: Correlates and trends, 1975-1979. *American Journal of Public Health, 71,* 59-69.

Bachman, J.G., Johnston, L.D., & O'Malley, P.M. (1987). *Monitoring the Future: Questionnaire responses from the nation's high school seniors, 1986.* Ann Arbor: Institute for Social Research.

Bachman, J.G., O'Malley, P.M., & Johnston, L.D. (1979). *Developing composite measures of drug use: Comparisons among lifetime, annual, and monthly prevalence reports for thirteen classes of drugs.* (Monitoring the Future Occasional Paper No. 5) Ann Arbor: Institute for Social Research.

Bachman, J.G., O'Malley, P.M., & Johnston, L.D. (1984). Drug use among young adults: The impacts of role status and social environments. *Journal of Personality and Social Psychology, 47,* 629-645.

Bentler, P.M. (1983). A multivariate view of marijuana decriminalization research. *Contemporary Drug Problems, 10,* 419-433.

Box, G.E.P., & Jenkins, G.M. (1976). *Time Series Analysis: Forecasting and Control* (Revised edition). San Francisco: Holden-Day.

Box, G.E.P., & Tiao, B.C. (1975). Intervention analysis with applications to economic and environmental problems. *Journal of the American Statistical Association, 70,* 70-79.

Choukroun, J., Ravn, I., & Wagner, C. (1985). The relationship between increases in minimum purchase age for alcoholic beverages and the number of traffic fatalities. Unpublished manuscript. University of Pennsylvania, Washington, D.C.: National Center for Education Social Systems Sciences Department.

Coate, D., & Grossman, M. (1988). Effects of alcoholic beverage prices and legal drinking ages on youth alcohol use. *Journal of Law and Economics, 31,* 145-171.

Cook, P.J., & Tauchen, G. (1984). The effect of minimum drinking age legislation on youthful auto fatalities, 1970-1977. *Journal of Legal Studies, 13,* 169-190.

Distilled Spirits Council of the United States. (1983). *Summary of state laws and regulations relating to distilled spirits.* (24th Edition, 1983). Washington, D.C.: Author.

Distilled Spirits Council of the United States. (1989). *Summary of state laws and regulations relating to distilled spirits.* (26th Edition, 1989). Washington, D.C.: Author.

Douglass, R.L. (1980). Lower legal drinking age in Michigan: One more time. *Journal of Traffic Safety Education, 37*(3), 11-12. (a)

Douglass, R.L. (1980). The legal drinking age and traffic casualties: A special case of changing alcohol availability in a public health context. In Wechsler, H. (Ed.), *Minimum-drinking-age laws: An evaluation.* Lexington, MA: Heath. (b)

DuMouchel, W., Williams, A.F., & Zador, P.L. (1987). Raising the alcohol purchase age: Its effect on fatal motor vehicle crashes in twenty-six states. *Journal of Legal Studies, 16,* 249-266.

Fishburne, P.M., Abelson, H.I., & Cisin, I.H. (1979). *The National Survey on Drug Abuse: 1979.* Washington, D.C.: National Institute on Drug Abuse.

George, W.H., Crowe, L.C., Abwender, D., & Skinner, J.B. (1989). Effects of raising the drinking age to 21 years in New York State on self-reported consumption by college students. *Journal of Applied Social Psychology, 19,* 623-635.

Hingson, R.W., Scotch, N., Mangione, T., Meyers, A., Glantz, L., Heeren, T., Lin, N., Mucatel, M., & Pierce, G. (1983). Impact of legislation raising the legal drinking age in Massachusetts from 18 to 20. *American Journal of Public Health, 73,* 163- 170.

Hoskin, A.F., Yalung-Mathews, D., & Carraro, B.A. (1986). The effect of raising the legal minimum drinking age on fatal crashes in 10 states. *Journal of Safety Research, 17,* 117-121.

Johnston, L.D., & O'Malley, P.M. (1985). Issues of validity and population coverage in student surveys of drug use. In B. Rouse et al. (Eds.), *Current challenges to drug abuse estimation.* (NIDA Research Monograph 57). Washington, D.C.: National Institute on Drug Abuse.

Johnston, L.D., O'Malley, P.M., & Bachman, J.G. (1981). *Marijuana decriminalization: The impact on youth, 1975-1980.* (Monitoring the Future Occasional Paper No. 13) Ann Arbor: Institute for Social Research.

Johnston, L.D. (1973). *Drugs and American youth.* Ann Arbor, MI: Institute for Social Research.

Kandel, D., Simcha-Fagan, O., & Davies, M. (1986). Risk factors for delinquency and illicit drug use from adolescence to young adulthood. *Journal of Drug Issues, 16,* 67-90.

Kandel, D.B. (1975). Reaching the hard-to-reach: Illicit drug use among high school absentees. *Addictive Diseases, 1,* 465-480.

Maisto, S.A., & Rachal, J.V. (1980). Indications of the relationship among adolescent drinking practices, related behaviors, and drinking-age laws. In H. Wechsler (Ed.), *Minimum-drinking-age laws: An evaluation.* Lexington, MA: Heath.

Males, M.A. (1986). The minimum purchase age for alcohol and young-driver fatal crashes: A long-term view. *Journal of Legal Studies, 15*, 181-211.

Moore, M.H., & Gerstein, D.R. (Eds.) (1981). *Alcohol and public policy: Beyond the shadow of prohibition.* Washington, D.C.: National Academy Press.

National Institute on Alcohol Abuse and Alcoholism. (1981). Minimum drinking age. *Alcohol Topics in Brief*, p. 3.

National Safety Council. (September 20, 1985). *Policy update.* Chicago, IL: Author.

NCA declares strategy. (August, 1982). *U.S. Journal*, p. 35.

Newman, J. (1987). Psychological effects on college students of raising the drinking age. *Adolescence, 22*, 503-510.

O'Donnell, Mary A. (1985). Research on drinking locations of alcohol-impaired drivers: Implications for Prevention Policies. *Journal of Public Health Policy, 6*, 510-525.

Polich, J.M. (1981). Epidemiology of alcohol abuse in military and civilian populations. *American Journal of Public Health, 71*, 1126-1132.

Rachal, J.V., Guess, L.L., Hubbard, R.L., Maisto, S.A., Cavanaugh, E.R., Waddell, R., & Benrud, C.H. (1980). *Adolescent drinking behavior.* Research Triangle Park, NC: Research Triangle Institute.

Room, R. (1971). Survey vs. sales data for the United States. *Drinking and Drug Practices Surveyor, 3*, 15-16.

Room, R. (1978). Evaluating the effects of drinking laws on drinking. In J.A. Ewing & B.A. Rouse (Eds.), *Drinking: Alcohol in American society.* Chicago: Nelson-Hall.

Rooney, J.F., & Schwartz, S.M. (1977). The effect of minimum drinking age laws upon adolescent alcohol use and problems. *Contemporary Drug Problems, 6*, 397-436.

Single, E., Kandel, D., & Johnson, B.D. (1975). The reliability and validity of drug use responses in a large scale longitudinal survey. *Journal of Drug Issues, 5*, 426-443.

Smart, R.G. (1975). Recent studies of the validity and reliability of self-reported drug use, 1970-1974. *Canadian Journal of Criminology and Corrections, 17*, 326-333.

Smart, R.G. (1976). *The new drinkers.* Toronto: Addiction Research Foundation.

Smart, R.G. (1977). Changes in alcoholic beverage sales after reductions in the legal drinking age. *Journal of Drug and Alcohol Education, 4*, 101-108.

Smart, R.G. (1979). Priorities in minimizing alcohol problems among young people. In H.T. Blane and M.E. Chafetz (Eds.), *Youth, alcohol, and social policy*. New York: Plenum.

Smart, R.G. (1980). An availability-proneness theory of illicit drug abuse. In D.J. Lettieri, M. Sayers, & H.W. Pearson (Eds.), *Theories on drug abuse: Selected contemporary perspectives* (NIDA Research Monograph 30). Rockville, MD: National Institute on Drug Abuse. (a)

Smart, R.G. (1980). The impact of changes in legal purchase or drinking age on drinking and admission to treatment. In H. Wechsler (Ed.), *Minimum-drinking-age laws: An evaluation*. Lexington, MA: Heath. (b)

Smart, R.G., & Goodstadt, M.S. (1977). Effects of reducing the legal alcohol purchasing age on drinking and driving problems: A review of empirical studies. *Journal of Studies on Alcohol, 38*, 1313-1323.

Smart, R.G., & Schmidt, W. (1975). Drinking and problems from drinking after a reduction in the minimum drinking age. *British Journal of Addiction, 70*, 347-358.

Smith, R.A., Hingson, R.W., Morelock, S., Heeren, T., Mucatel, M., Mangione, T., & Scotch, N. (1984). Legislation raising the legal drinking age in Massachusetts from 18 to 20: Effect on 16 and 17 year-olds. *Journal of Studies on Alcohol, 45*, 534-539.

Stern, J.D., & Chandler, M.O. (Eds.). (1988). *1988 Education Indicators*. Washington, D.C.: National Center for Education Statistics.

Straus, R. (1984). Comment. In Gerstein, D.R. (Ed.) *Toward the prevention of alcohol problems: Government, business, and community action*. Washington, D.C.: National Academy Press.

Van Dyke, J., & Womble, K.B. (November 1988). The impact of minimum drinking age laws on fatal crash involvements: An update of the NHTSA analysis. *U. S. Department of Transportation, National Highway Transportation Safety Administration Technical Report*. DOT HS807 349.

Vingilis, E.R., & DeGenova, K. (1984). Youth and the forbidden fruit: Experiences with changes in the legal drinking age in North America. *Journal of Criminal Justice, 12*, 161-172.

Wagenaar, A.C. (1980). The minimum legal drinking age: A time-series impact evaluation. Doctoral dissertation, The University of Michigan.

Wagenaar, A.C. (1981). Effects of an increase in the legal minimum drinking age. *Journal of Public Health Policy, 2*, 206-225. (a)

Wagenaar, A.C. (1981). Effects of the raised legal drinking age on motor vehicle accidents in Michigan. *The HSRI Research Review, 11*(4), 1-8. (b)

Wagenaar, A.C. (1981). Legal minimum drinking age changes in the United States: 1970-1981. *Alcohol Health and Research World, 6*(2), 21-26. (c)

Wagenaar, A.C. (1982). Aggregate beer and wine consumption: Effects of changes in the minimum legal drinking age and a mandatory beverage container deposit law in Michigan. *Journal of Studies in Alcohol, 43*, 469-487. (a)

Wagenaar, A.C. (1982). Preventing highway crashes by raising the legal minimum age for drinking: An empirical confirmation. *Journal of Safety Research, 13*, 57-71. (b)

Wagenaar, A.C. (1983). *Alcohol, young drivers, and traffic accidents: Effects of minimum-age laws*. Lexington, Mass.: D.C. Heath and Co. (a)

Wagenaar, A.C. (1983). Public policy effects on alcohol consumption in Maine and New Hampshire: 1970-1980. *Contemporary Drug Problems, 11*, 3-30. (b)

Wagenaar, A.C. (1983). Raising the legal drinking age in Maine: Impact on traffic accidents among young drivers. *International Journal of the Addictions, 18*, 365-377. (c)

Wagenaar, A.C. (1986). Preventing highway crashes by raising the legal minimum age for drinking: The Michigan experience 6 years later. *Journal of Safety Research, 17*, 101-109.

Wagenaar, A.C., & Maybee, R.G. (1986). The legal minimum drinking age in Texas: Effects of an increase from 18 to 19. *Journal of Safety Research, 17*, 165-178.

Whitehead, P.C. (1977). *Alcohol and young drivers: Impact and implications of lowering the drinking age*. (Nonmedical use of drugs directorate monograph series no. 1.) Ottawa: Department of National Health and Welfare.

Whitehead, P.C. (1980). Research strategies to evaluate the impact of changes in the legal drinking age. In H. Wechsler (Ed.), *Minimum-drinking-age laws: An evaluation*. Lexington, MA: Heath.

Williams, A.F., Rich, R.F., Zador, P.L., Robertson, L.S. (1975). The legal minimum drinking age and fatal motor vehicle crashes. *Journal of Legal Studies, 4*, 219-239.

Williams, A.F. Zador, P.L., Harris, S.S., & Karpf, R.S. (1983). The effect of raising the legal minimum drinking age on involvement in fatal crashes. *Journal of Legal Studies, 12*, 169-179.

Willi ..s, T.P., & Lillis, R.P. (1986). Changes in alcohol consumption by 18-year-olds following an increase in New York State's purchase age to 19. *Journal of Studies on Alcohol, 47*, 290-296.

Williams, T.P., & Lillis, R.P. (1988). Long-term changes in reported alcohol purchasing and consumption following an increase in New York State's purchase age to 19. *British Journal of Addiction, 83*, 209-217.

Zylman, R. (1976). Drinking practices among youth are changing regardless of legal drinking age. *Journal of Traffic Safety Education, 24*, 31-32,37.

Table 1

Cohort-Sequential Design of Monitoring the Future Project
(Entries indicate modal age of respondents)

Class of	Year of Data Collection											
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
1976	18	19	20	21	22	23	24	25	26	27	28	29
1977		18	19	20	21	22	23	24	25	26	27	28
1978			18	19	20	21	22	23	24	25	26	27
1979				18	19	20	21	22	23	24	25	26
1980					18	19	20	21	22	23	24	25
1981						18	19	20	21	22	23	24
1982							18	19	20	21	22	23
1983								18	19	20	21	22
1984									18	19	20	21
1985										18	19	20
1986											18	19
1987												18

Note: Age 18 indicates base-year data collection, in senior year of high school; other ages correspond to follow-up data collections.

Table 2

Response Rate in Follow-Up Surveys
by Number of Years After High School
Classes of 1976–1986 Followed in 1977–1987

Number of Years After High School	Average Response Rate
1	83.3%
2	82.5%
3	80.3%
4	79.3%
5	78.6%
6	77.8%
7	76.3%
8	75.3%
9	73.7%
10	74.3%
11	70.6%

Table 3
Minimum Drinking Ages by States, 1976-1987

State	Year											
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Alabama	19	19	19	19	19	19	19	19	19	19*	21*	21*
Alaska	19	19	19	19	19	19	19	19*	21	21	21	21
Arkansas	21	21	21	21	21	21	21	21	21	21	21	21
Arizona	19	19	19	19	19	19	19	19	19*	21*	21*	21
California	21	21	21	21	21	21	21	21	21	21	21	21
Colorado	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'
Connecticut	18	18	18	18	18	18	18*	19*	20	20*	21*	21
Delaware	20	20	20	20	20	20	20	20*	21'	21	21	21
D.C.	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'*	21*
Florida	18	18	18	18	18*	19	19	19	19	19*	21*	21
Georgia	18	18	18	18	18*	19	19	19	19	19*	20*	21
Hawaii	18	18	18	18	18	18	18	18	18	18	18*	21
Iowa	18	18	18*	19	19	19	19	19	19	19	19*	21*
Idaho	19	19	19	19	19	19	19	19	19	19	19	19
Illinois	19,21'	19,21'	19,21'	19,21'*	21	21	21	21	21	21	21	21
Indiana	21	21	21	21	21	21	21	21	21	21	21	21
Kansas	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'*	18,21'*	21*	21
Kentucky	21	21	21	21	21	21	21	21	21	21	21	21
Louisiana	18	18	18	18	18	18	18	18	18	18	18	18
Massachusetts	18	18	18	18*	20	20	20	20	20	20*	21*	21
Maryland	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'*	21*	21*	21	21	21
Maine	18	18*	20	20	20	20	20	20	20	20*	21*	21
Michigan	18	18	18*	21	21	21	21	21	21	21	21	21
Minnesota	18*	19	19	19	19	19	19	19	19	19	19*	21*
Missouri	21	21	21	21	21	21	21	21	21	21	21	21
Mississippi	18,21''	18,21''	18,21''	18,21''	18,21''	18,21''	18,21''	18,21''	18,21''	18,21''	18,21''*	21
Montana	18	18	18*	19	19	19	19	19	19	19	19*	21
North Carolina	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'*	19,21'	19,21'	19,21'*	21
North Dakota	21	21	21	21	21	21	21	21	21	21	21	21
Nebraska	19	19	19	19	19*	20*	20	20	20*	21*	21	21
Nevada	21	21	21	21	21	21	21	21	21	21	21	21
New Jersey	18	18	18	18*	19*	19	19*	21*	21*	21	21	21
New Hampshire	18	18	18	18*	20	20	20	20	20	20*	21*	21
New Mexico	21	21	21	21	21	21	21	21	21	21	21	21
New York	18	18	18	18	18	18	18*	19	19	19*	21	21
Ohio	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'	18,21'*	19,21'	19,21'	19,21'	19,21'	19,21'

Table 3
Minimum Drinking Ages by States, 1976-1987
(Continued)

State	Year											
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
Oklahoma	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1*]	21	21	21	21
Oregon	21	21	21	21	21	21	21	21	21	21	21	21
Pennsylvania	21	21	21	21	21	21	21	21	21	21	21	21
Rhode Island	18	18	18	18	18*	19*	20	20	20*	21	21	21
South Carolina	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1*]	19,21[1]	19,21[1]	19,21[1*]	21
South Dakota	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1*]	19,21[1]	19,21[1]	19,21[1]
Tennessee	18	18	18	18*	19	19	19	19	19*	21*	21*	21
Texas	18	18	18	18	18	18*	19	19	19	19	19*	21
Utah	21	21	21	21	21	21	21	21	21	21	21	21
Virginia	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1]	18,21[1*]	18,21[1*]	18,21[1*]	19,21[1]	19,21[1*]	21*	21
Vermont	18	18	18	18	18	18	18	18	18	18	18*	21*
Washington	21	21	21	21	21	21	21	21	21	21	21	21
Wisconsin	18	18	18	18	18	18	18	18	18*	19	19*	21*
West Virginia	18	18	18	18	18	18	18	18*	19	19	19*	21
Wyoming	19	19	19	19	19	19	19	19	19	19	19	19

Notes:
Data from Distilled Spirits Council (198', 1983, 1985, 1989); DuMouchel, Williams, & Zador (1987); Insurance Institute (various years); National Safety Council (1985); and Wagenaar (1983b).

*Indicates that a change in the minimum drinking age occurred. The asterisk is placed between the last data collection before the change went into effect and the first data collection after the change went into effect.

[1]First age is for beer and wine; second age is for distilled spirits.
[2]First age is for beer; second age is for wine and distilled spirits.
[3]Drinking age is 18 for beer or wine that is 4% or less alcohol.
[4]18 for on-premise consumption, 19 for off-premise.
[5]Grandfather clause in effect.

Table 4

Numbers of Seniors by States, 1976-1987

State	Year												Total
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	
AL	117	237	153	190	199	142	131	357	269	156	382	402	2735
AZ	412	434	394	450	276	382	224	178	441	425	225	288	4129
AR	611	668	601	400	416	692	516	256	270	286	97	92	4905
CA	2631	2828	2575	1222	1909	1920	1929	1647	1562	1754	1709	2070	23756
CO	70	72	153	111	170	207	78	62	182	189	95	198	1587
CT	272	630	688	150	234	654	542	324	446	499	452	451	5342
DE	0	0	0	0	0	0	99	204	167	186	162	0	818
DC	0	0	0	0	211	99	0	0	74	0	147	148	679
FL	323	508	687	555	612	824	541	585	663	619	740	911	7568
GA	376	441	552	414	574	555	504	389	377	586	610	610	5988
IL	816	836	1182	1033	819	1052	1041	816	936	551	711	1036	10829
IN	333	374	170	152	234	245	380	434	212	353	361	277	3525
IA	709	683	366	408	271	195	303	223	104	108	0	363	3733
KS	0	0	0	0	0	0	0	0	0	0	0	96	96
KY	319	297	176	319	320	543	720	271	374	478	471	153	4441
LA	195	263	277	256	188	210	373	434	431	335	92	85	3139
ME	920	850	961	231	420	420	118	90	81	134	135	0	4360
MD	281	76	171	84	87	0	0	0	148	152	0	245	1244
MA	362	433	563	750	608	494	572	517	518	526	382	288	6013
MI	1058	930	1064	1366	877	992	1044	892	977	896	1060	1329	12485
MN	335	695	688	223	286	430	433	269	251	574	650	268	5102
MS	54	63	231	139	0	99	30	151	126	115	111	0	1119
MO	333	492	278	441	325	358	456	286	83	326	553	273	4204
NE	0	79	94	85	224	269	314	87	51	227	143	0	1573
NH	0	0	0	0	0	0	0	0	0	0	0	241	241
NJ	928	721	946	838	679	509	988	840	435	420	777	1013	9094
NY	1254	1332	2471	1252	1467	1189	1135	1020	1056	1084	886	1220	15366
NC	449	640	1275	419	448	531	175	481	516	208	422	286	5850
ND	0	0	0	239	0	0	0	0	0	0	77	95	411
OH	2030	2360	2430	1156	1202	1345	1081	904	1103	1370	587	396	15964
OK	161	114	151	407	404	79	88	318	315	68	76	0	2181
OR	286	196	170	381	318	289	317	337	338	244	281	181	3338
PA	848	1331	1206	705	873	1003	1364	1339	1122	952	801	662	12206
SC	175	157	205	201	171	188	466	530	270	268	0	0	2631
SD	261	537	399	182	0	0	0	184	160	0	0	0	1723
TN	128	107	103	180	204	106	97	0	0	0	507	599	2031
TX	398	552	710	567	318	627	426	557	884	905	587	756	7287
UT	248	257	306	256	315	320	294	346	291	217	218	0	3068
VA	590	570	868	582	337	441	897	841	542	604	375	398	7045
WA	389	274	344	218	248	227	373	480	283	183	450	421	3890
WV	0	215	0	0	178	180	128	148	300	297	131	325	1902
WI	168	253	193	100	102	183	171	150	141	207	250	531	2449
WY	0	0	0	0	0	0	0	0	0	0	0	111	111
TOTAL	18840	21505	23801	16662	16524	17999	18348	16947	16499	16502	15713	16818	216158

Table 5

Numbers of Schools by States, 1976-1987

State	Year												Total
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	
AL	2	1	1	1	1	2	2	2	2	1	3	4	22
AZ	3	2	3	3	2	2	2	2	2	2	1	1	25
AR	4	3	3	5	5	5	5	3	3	2	1	2	41
CA	20	22	22	11	16	14	13	14	17	17	13	15	194
CO	3	3	1	1	2	2	2	2	1	1	1	2	21
CT	2	3	3	1	1	3	3	2	3	3	4	5	33
DE	0	0	0	0	0	0	1	1	1	1	1	0	5
DC	0	0	0	0	3	1	0	0	1	0	1	1	7
FL	3	3	3	3	5	6	3	3	7	7	6	7	56
GA	2	3	3	3	3	3	3	4	4	4	5	5	42
IL	8	8	6	7	6	7	8	11	10	6	7	9	93
IN	1	1	1	1	1	1	3	4	2	3	3	3	24
IA	5	5	4	2	2	3	4	2	2	2	0	2	33
KS	0	0	0	0	0	0	0	0	0	0	0	3	3
KY	4	4	4	5	4	4	5	2	2	3	4	2	43
LA	2	3	5	4	2	3	4	3	5	4	2	2	39
ME	5	5	5	1	3	4	2	1	1	1	1	0	29
MD	1	1	3	2	1	0	0	0	1	1	0	2	12
MA	3	3	4	6	5	4	4	4	4	4	4	3	48
MI	6	5	6	8	7	7	8	6	8	9	10	9	89
MN	2	3	3	2	2	2	2	2	2	3	4	4	31
MS	1	1	4	3	0	1	1	2	1	1	1	0	16
MO	3	4	4	5	3	3	4	4	2	2	5	3	42
NE	0	4	3	3	5	6	4	2	1	2	1	0	31
NH	0	0	0	0	0	0	0	0	0	0	0	2	2
NJ	6	5	6	7	5	3	7	6	3	3	4	4	59
NY	9	10	16	8	9	8	8	8	7	9	9	10	111
NC	3	3	6	3	3	3	1	2	2	2	4	2	34
ND	0	0	0	1	0	0	0	0	0	0	2	2	5
OH	13	16	16	7	8	8	8	9	10	10	4	3	112
OK	1	1	1	2	2	1	1	1	1	2	2	0	15
OR	3	2	2	3	3	2	2	3	3	2	2	1	28
PA	5	6	6	4	5	6	10	9	6	6	6	5	74
SC	1	1	2	2	1	1	2	2	3	3	0	0	18
SD	3	5	4	2	0	0	0	1	1	0	0	0	16
TN	2	1	1	1	1	1	1	0	0	0	2	3	13
TX	3	3	3	3	2	3	3	5	5	6	5	7	48
UT	2	2	2	2	2	2	2	2	2	2	2	0	22
VA	3	3	5	4	2	2	5	5	3	3	3	3	41
WA	2	3	3	2	2	2	2	2	2	2	3	2	27
WV	0	1	0	0	1	1	1	1	2	2	1	2	12
WI	1	1	1	2	2	1	1	2	2	1	2	3	19
WY	0	0	0	0	0	0	0	0	0	0	0	2	2
TOTAL	137	150	165	130	127	127	137	134	134	132	129	135	1637

Table 6

Numbers of Seniors
by Minimum Drinking Age (3 category), 1976–1987

Miniumum Drinking Age	Year												Total
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	
18 (Some)	11497	11657	14503	8343	6703	6032	5164	3722	973	639	445	283	69961
Percent	*61.0*	*54.2*	*60.9*	*50.1*	*40.6*	*33.5*	*28.1*	*22.0*	*5.9*	*3.9*	*2.8*	*1.7*	*32.4*
19-20	1345	3131	3472	2620	3167	4326	4750	5281	8013	7526	3237	507	47375
Percent	*7.1*	*14.6*	*14.6*	*15.7*	*19.2*	*24.0*	*25.9*	*31.2*	*48.6*	*45.6*	*20.6*	*3.0*	*21.9*
21 (All)	5998	6717	5826	5699	6654	7641	8434	7944	7513	8337	12031	16028	98847
Percent	*31.8*	*31.2*	*24.5*	*34.2*	*40.3*	*42.5*	*46.0*	*46.9*	*45.5*	*50.5*	*76.6*	*95.3*	*45.7*
Total	18840	21505	23801	16662	16524	17999	18348	16947	16499	16502	15713	16818	216158

Table 7

Numbers of States and Seniors in the Monitoring the Future Surveys with Consistent Minimum Drinking Ages 1976–1981

Minimum Drinking Age	1976–1981		
	# of States	# of Seniors	% of Seniors
Low (18 some)	16	41569	*52.5*
Mixed (19–20)	3	4137	*5.2*
High (21 all)	10	33429	*42.2*
Total	29	79135	*100.*

Table 8

Regression Analysis: Background Variables Related to Alcohol Use in States with No Change in Minimum Drinking Age High School Classes of 1976 - 1981

Independent Variables	Prevalence of Alcohol Use in Last 30 Days		Prevalence of Heavy Drinking in Last 2 Weeks	
	B[1]	Beta[2]	B[1]	Beta[2]
Sex (M=1, F=2)	−0.086	−0.094*	−0.188	−0.193*
Race(W=0, B=1)	−0.188	−0.143*	−0.178	−0.128*
College Plans (No=0,Yes=1)	−0.030	−0.033*	−0.081	−0.082*
# Parents in Household (0,1,2)	−0.005	−0.007	−0.015	−0.017
Parental Education (10–60)	0.002	0.051*	0.000	0.013*
Religiosity (10–40)	−0.010	−0.199*	−0.009	−0.164*
Region[3]				
South (=1)	−0.029	−0.031	−0.036	−0.035*
Northeast (=1)	0.023	0.021	−0.018	−0.015
West (=1)	−0.084	−0.075*	−0.099	−0.085*
Urbanicity (1–5)	0.020	0.048*	0.009	0.019
MDA: 18 (=1)	0.056	0.060*	0.028	0.029*
MDA: 19-20 (=1)	0.024	0.013	0.008	0.004
Constant	1.017		0.996	
Percent Variance Explained		10.4%		11.1%

[1] The values in this column are unstandardized regression coefficients.

[2] The values in this column are standardized regression coefficients.

[3] Dummy variables were used for region, and therefore one region (North Central) was excluded.

Notes: The weighted number of cases is approximately 66,000. Even assuming an unlikely large design effect of 11, the effective N would be more than 6,000; the value used in calculating significance levels is 6,000. (A large number of design effects have been calculated for various statistics; a very few have been as large as 11.)

* = $p<.05$ (for both standardized and unstandardized coefficients)

Table 9

Mean Alcohol Use (30-Day)
3 Years Before and After Change in Minimum Drinking Age
By Background and Demographic Factors

Independent Variables	Number of Cases		Mean Alcohol Use Past 30 Days		St Dev (6 yrs)	%Standard Deviation Change
	Before	After	Before	After		
SEX						
Male	12045	11196	3.181	2.945	1.698	−13.9%
Female	12682	12187	2.636	2.447	1.485	−12.7%
RACE						
White	20844	19444	3.025	2.809	1.604	−13.5%
Black	2752	2618	1.927	1.867	1.312	−4.6%
COLLEGE PLANS						
NonCollege Bound	10778	9450	3.060	2.800	1.700	−15.3%
College Bound	12809	13042	2.783	2.599	1.524	−12.1%
RELIGIOUS COMMITMENT						
Low	11497	10472	3.245	2.992	1.651	−15.3%
High	13223	12985	2.606	2.438	1.525	−11.0%
POPULATION DENSITY						
Large SMSA	4824	4818	3.116	2.897	1.602	−13.7%
Other SMSA	13027	11717	2.848	2.648	1.610	−12.4%
NonSMSA	7246	7585	2.877	2.632	1.642	−14.9%

Table 10

FARS Data
Effects of Increased
Minimum Drinking Age on Alcohol-Involved Fatal Crashes

Type of Change	Single-Vehicle Nighttime		Daytime	
	Less Than 21	21 and Older	Less Than 21	21 and Older
Rate of Crashes				
Aggregate	−15.4*	−5.4	−13.9	−13.3*
3-Year	−26.3*	−17.7*	−30.8*	−15.5*
2-Year	−18.6*	−9.9*	−26.7*	−13.5*
1-Year	−21.6*	0.6	2.1	−13.0*
Grandfathered	−23.9*	−16.6*	−18.6*	−11.9*
NonG'fathered	−20.0*	−3.5	−11.6	−12.3*
Frequency of Crashes				
Aggregate	−13.2	−4.2	−15.2	−5.5
3-Year	−27.8*	−12.8*	−33.8*	−11.0*
2-Year	−22.9*	−4.3	−30.2*	−7.5*
1-Year	−24.8*	3.3	1.3	−3.3
Grandfathered	−26.0*	−6.9*	−20.8*	−1.2
NonG'fathered	−23.2*	−2.1	−12.4	−5.4*

* = Change estimate is significantly different from 0, $p < .05$.

Figure 1

Alcohol Use (30-Day Mean) by Minimum Drinking Age – 1976-1981

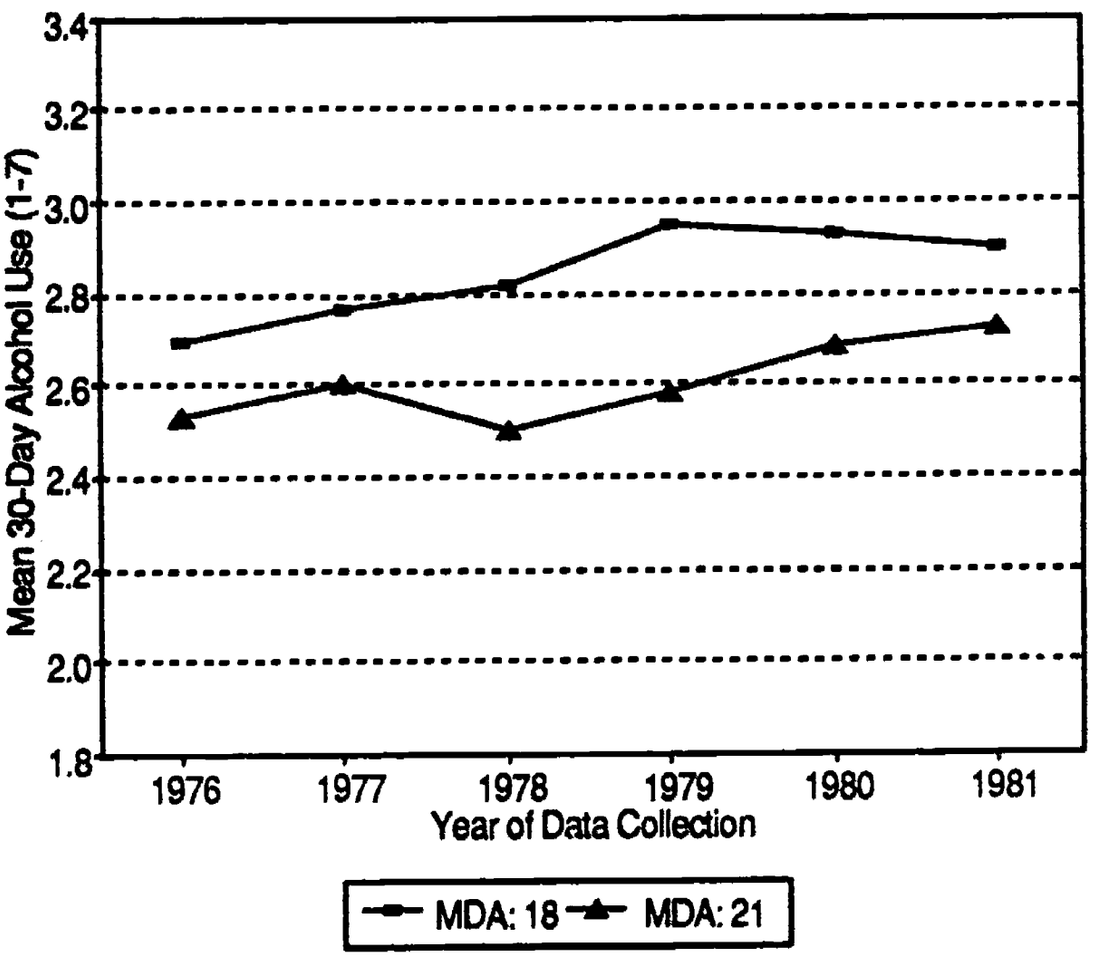


Figure 2

Alcohol Use (Heavy Drinking Mean) by Minimum Drinking Age – 1976-1981

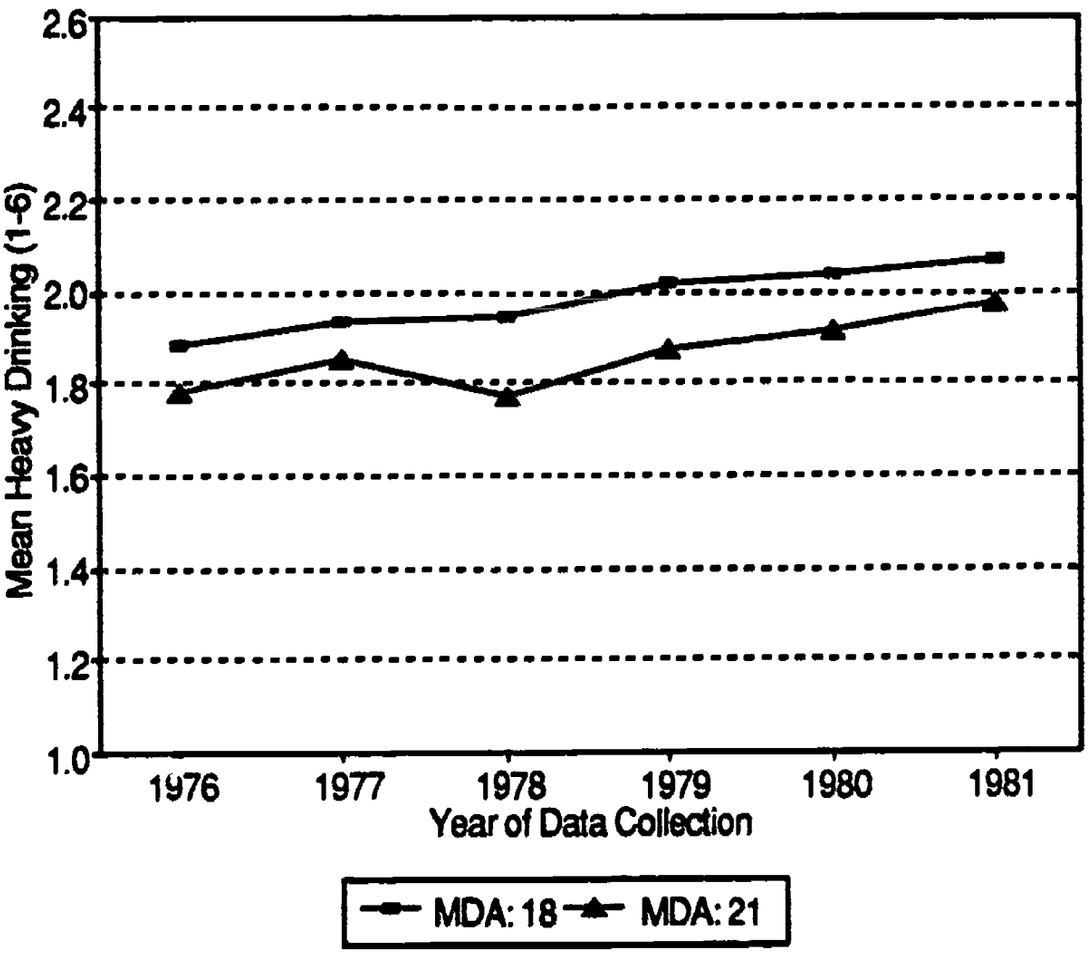


Figure 3

Prevalence of 30-Day Alcohol Use by Minimum Drinking Age – 1976-1981

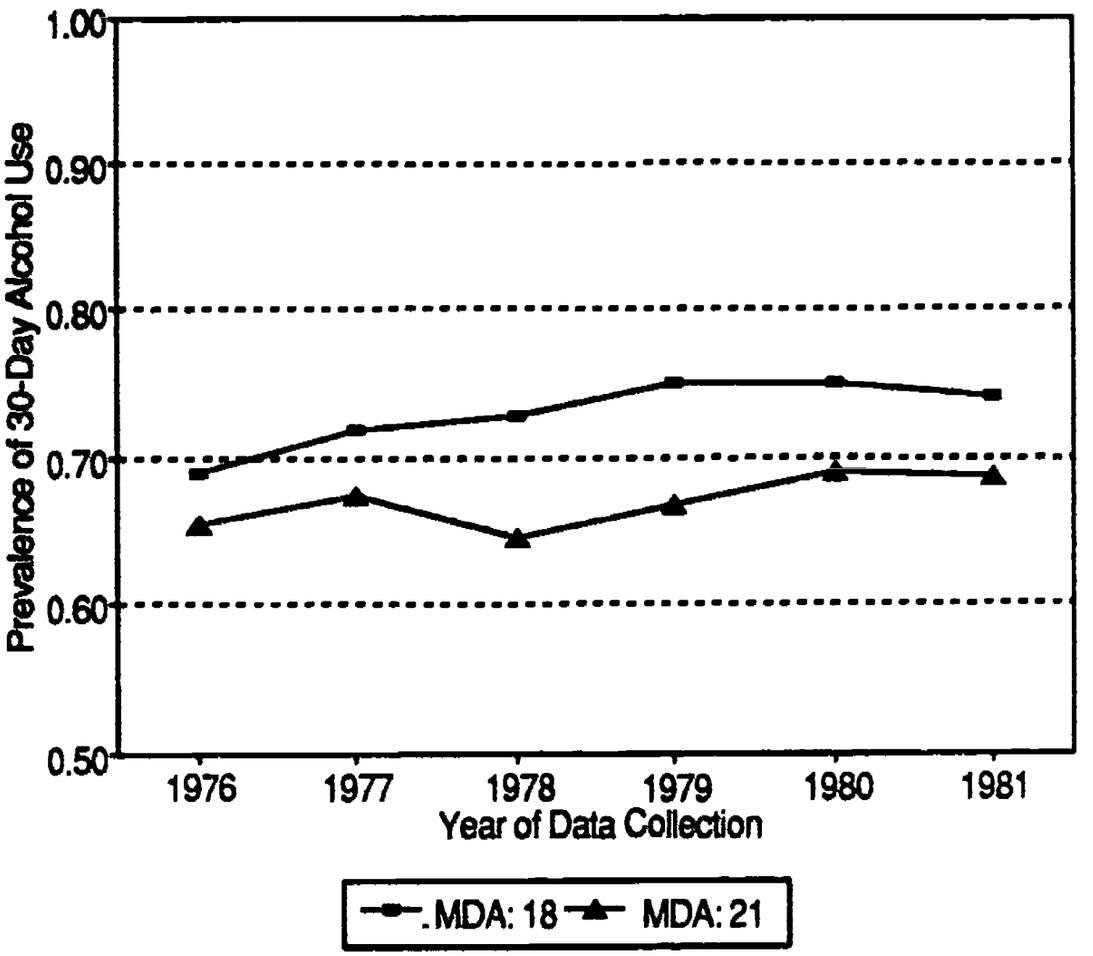


Figure 4

Prevalence of Heavy Drinking (Last 2 Weeks) by Minimum Drinking Age – 1976-1981

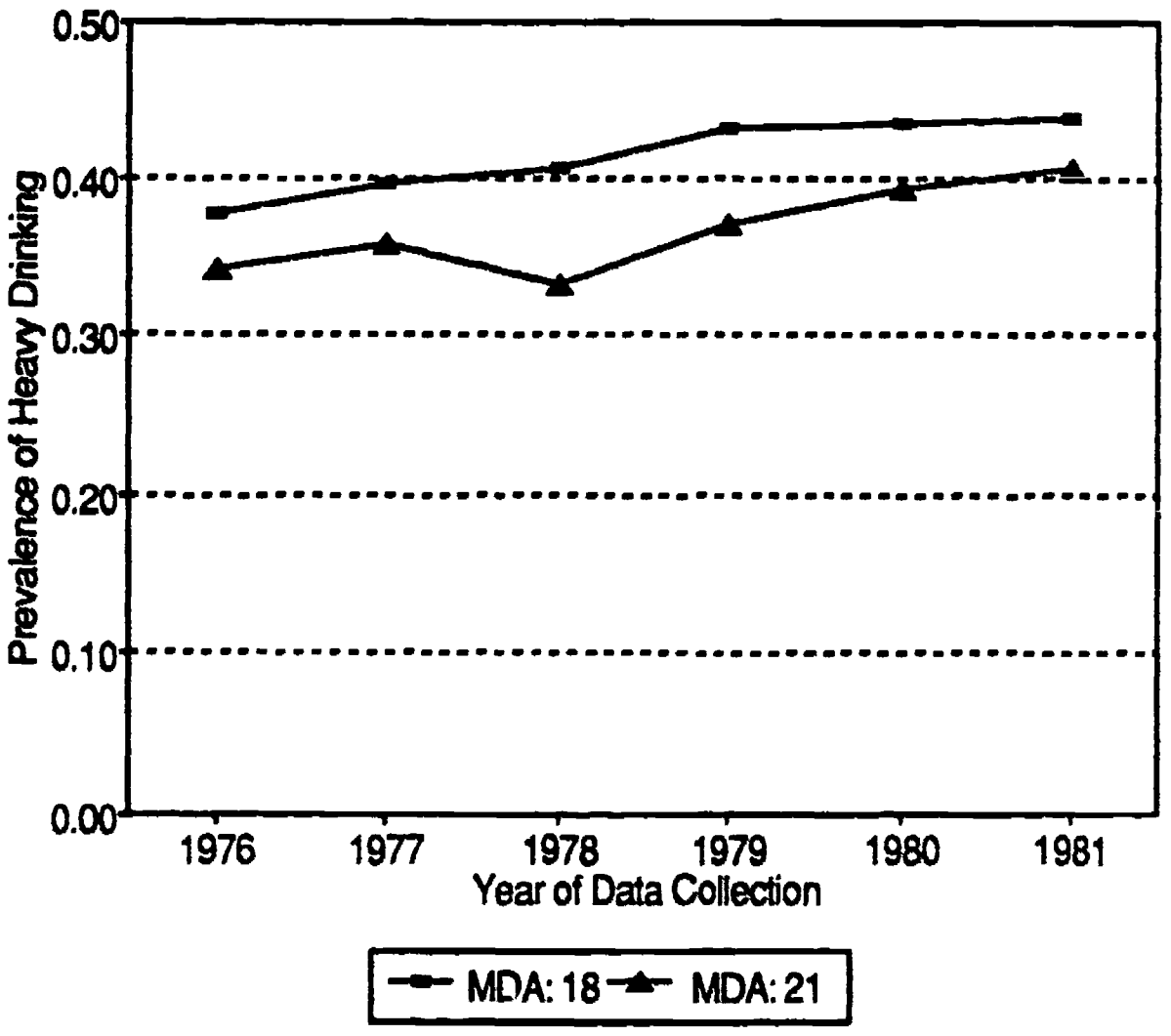


Figure 5

Alcohol Use (30-Day Mean) by 2 Groups of States – 1976-1987

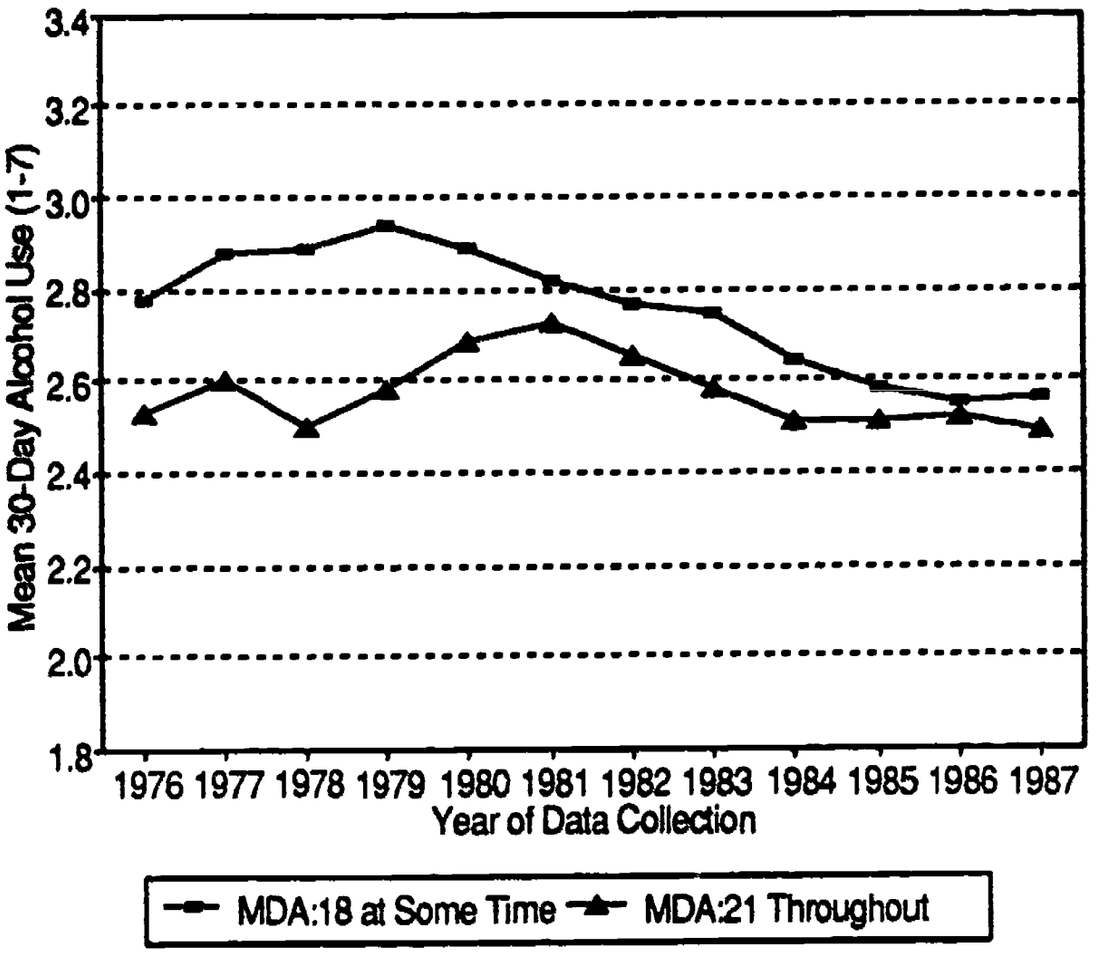


Figure 6

Alcohol Use (Heavy Drinking Mean) by 2 Groups of States – 1976-1987

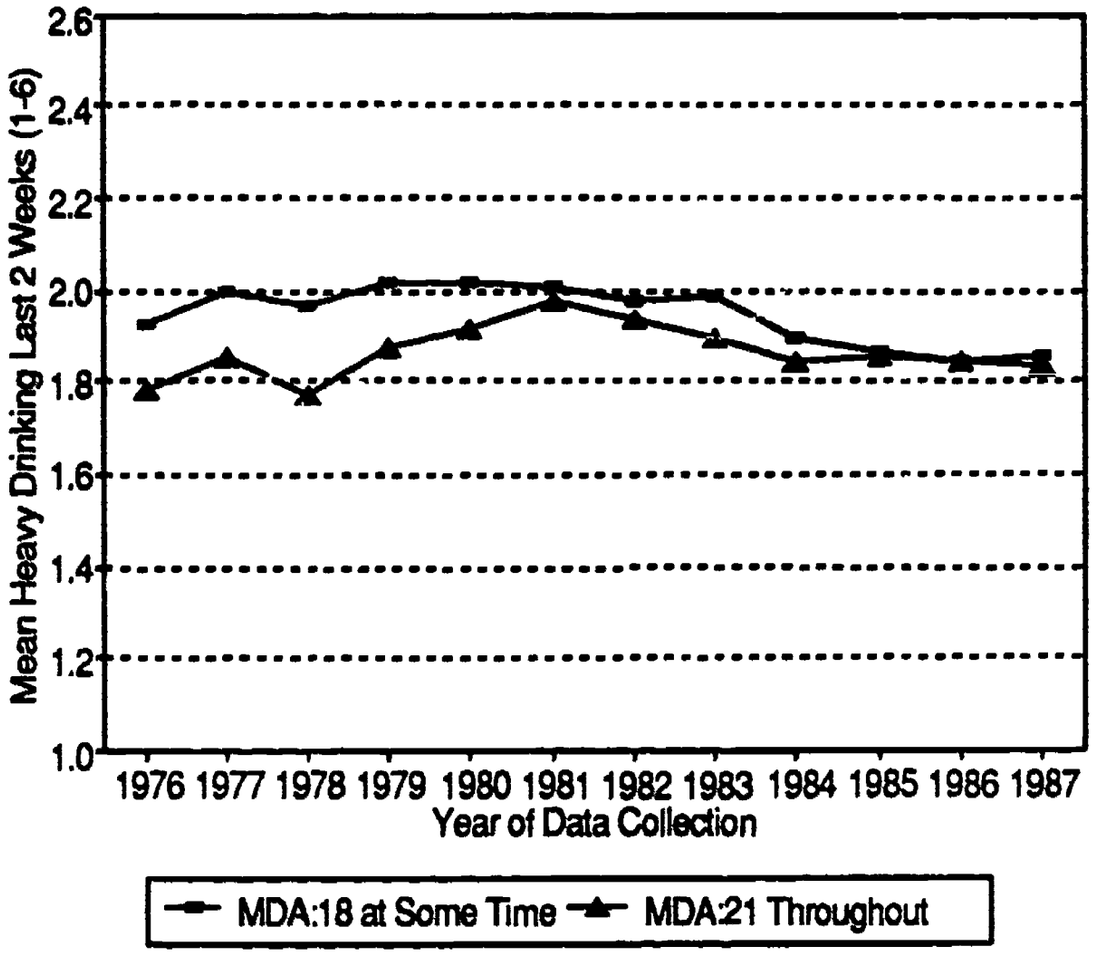


Figure 7

Prevalence of 30-Day Alcohol Use by 2 Groups of States – 1976-1987

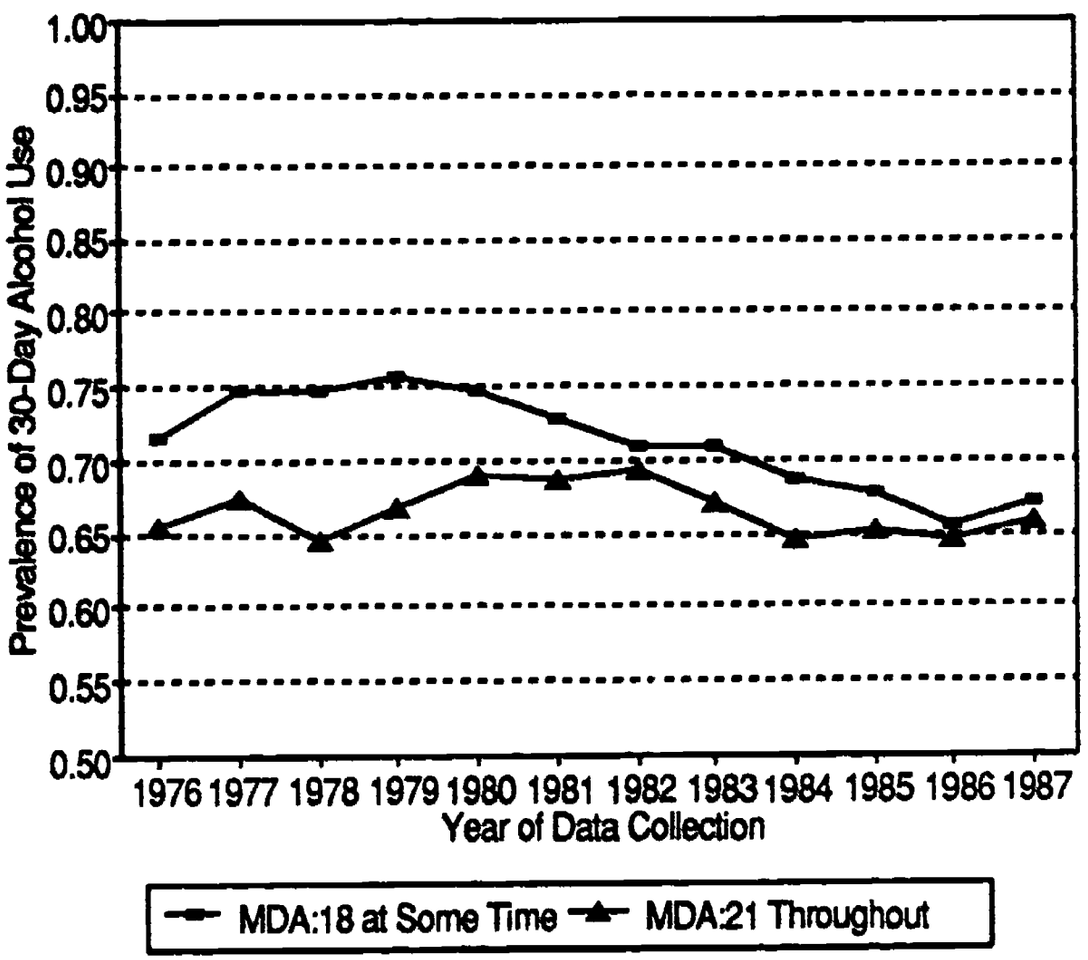


Figure 8

Prevalence of Heavy Drinking (Last 2 Weeks) by 2 Groups of States – 1976-1987

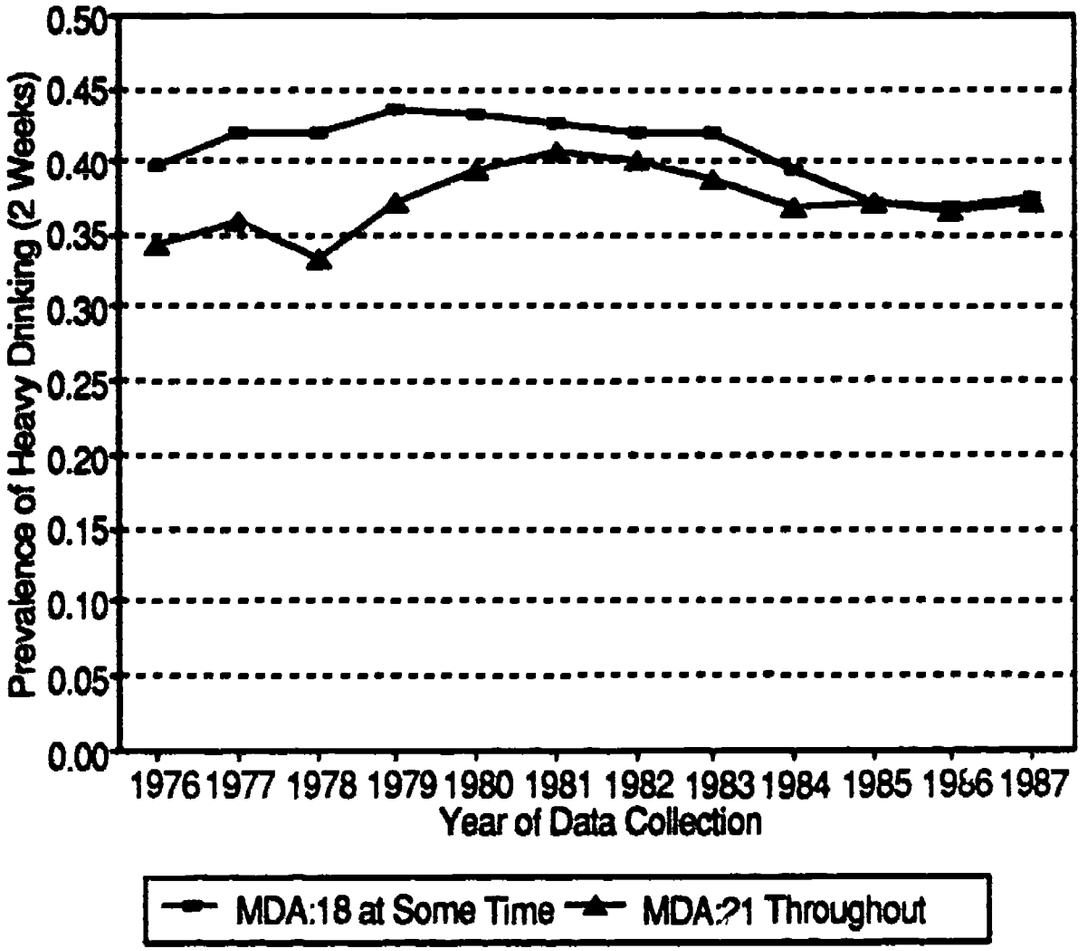


Figure 9

Alcohol Use (30 Day Mean) by Year and Base-Year Minimum Drinking Age
College Students, 1-4 Years After High School

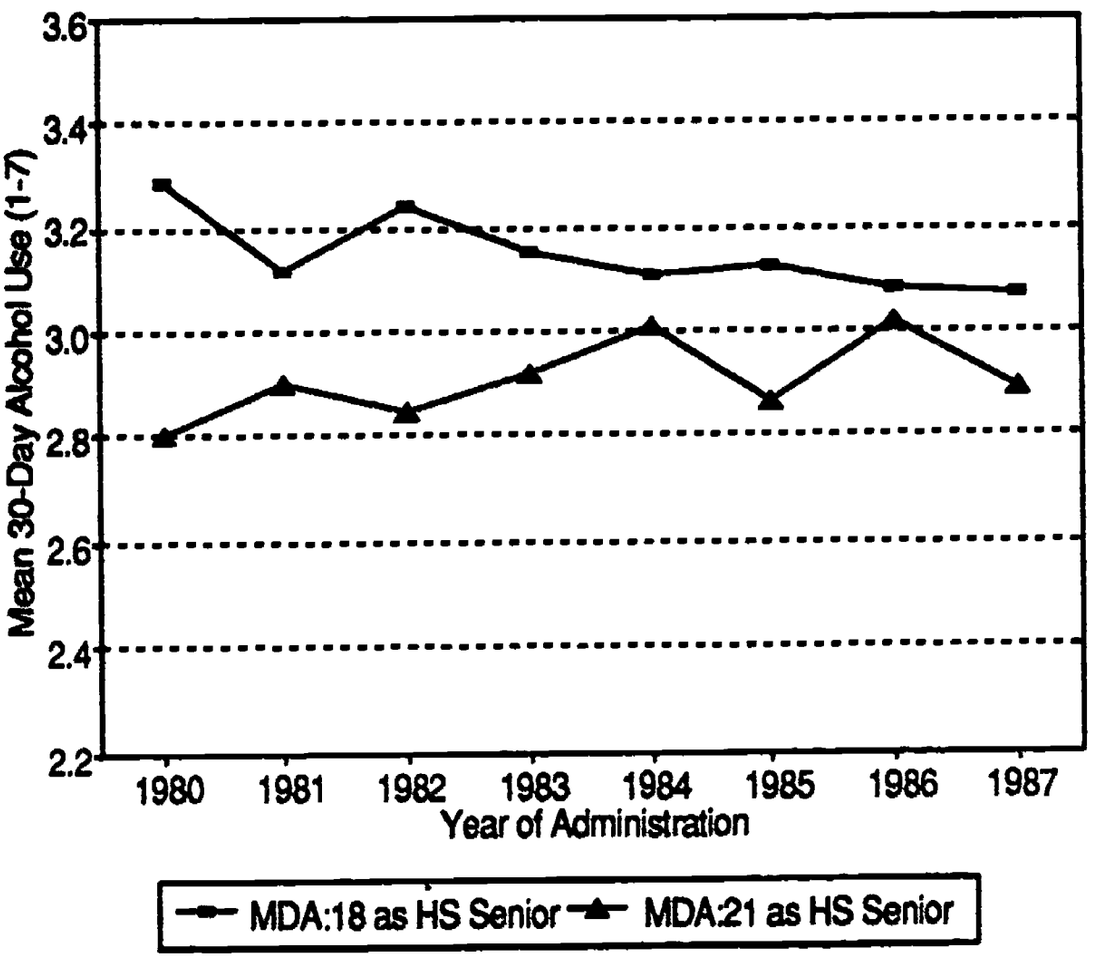


Figure 10

Alcohol Use (30 Day Mean) by Year and Base-Year Minimum Drinking Age Non-College Students, 1-4 Years After High School

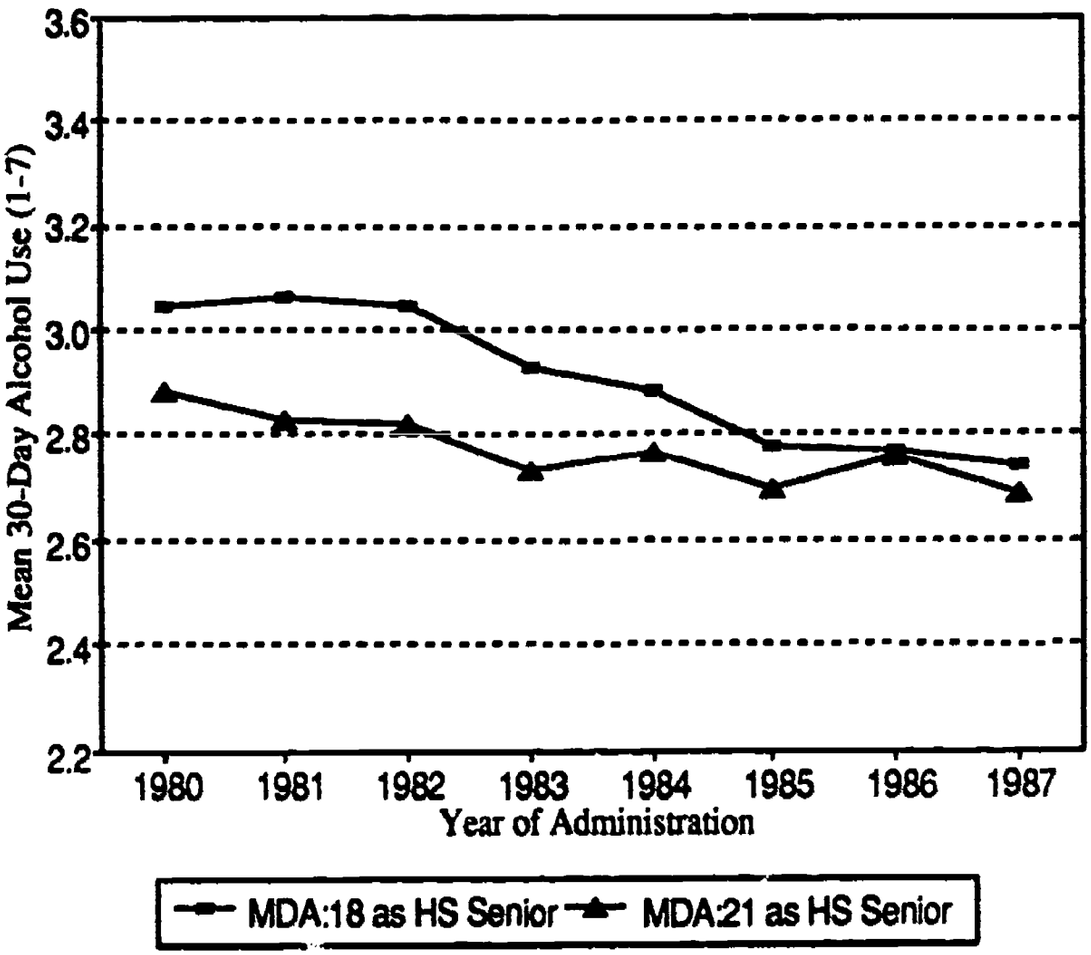


Figure 11

Alcohol Use (30-Day Mean) by Age and Minimum Drinking Age (Classes of 1976-1981 Followed-up in 1979-1987)

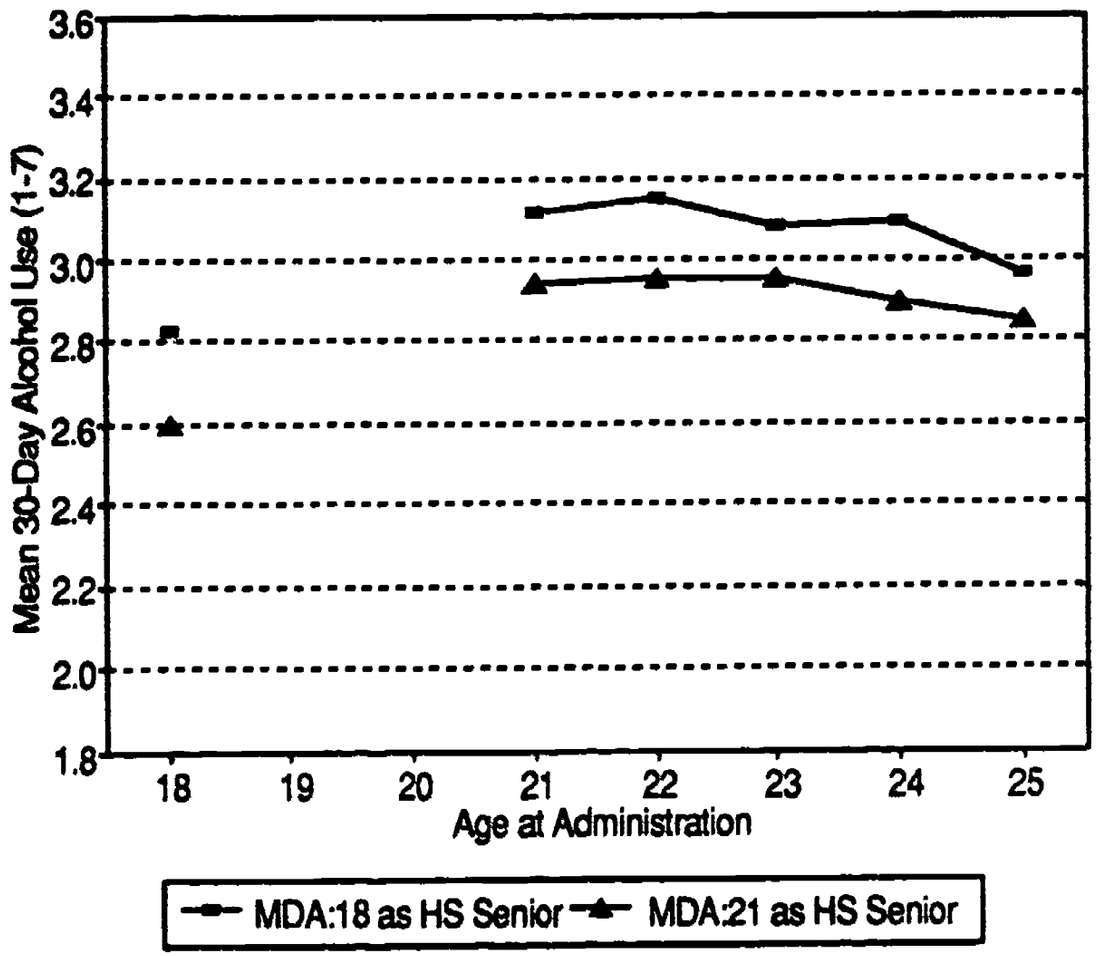


Figure 12

Alcohol Use (Heavy Drinking Mean) by Age and Minimum Drinking Age (Classes of 1976-1981 Followed-up in 1979-1987)

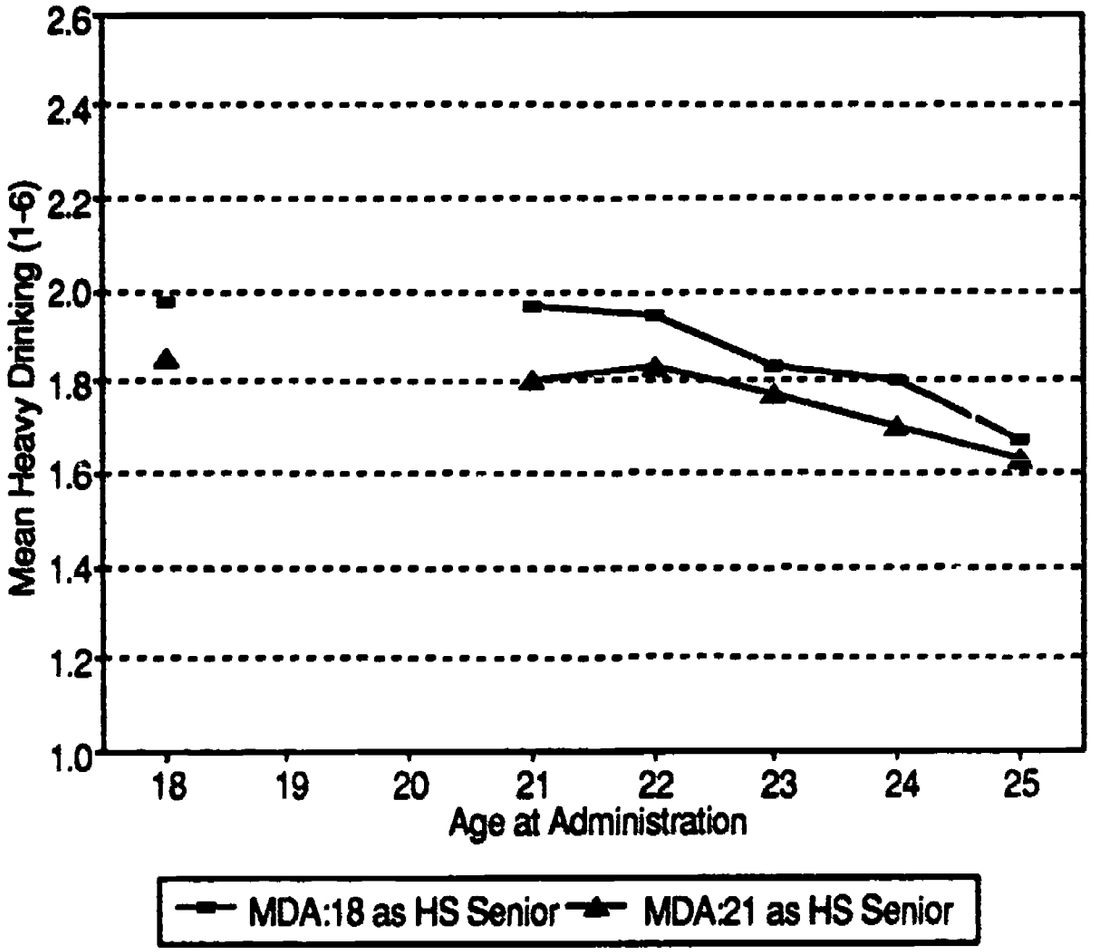


Figure 13

Prevalence of 30-Day Alcohol Use by Age and Minimum Drinking Age

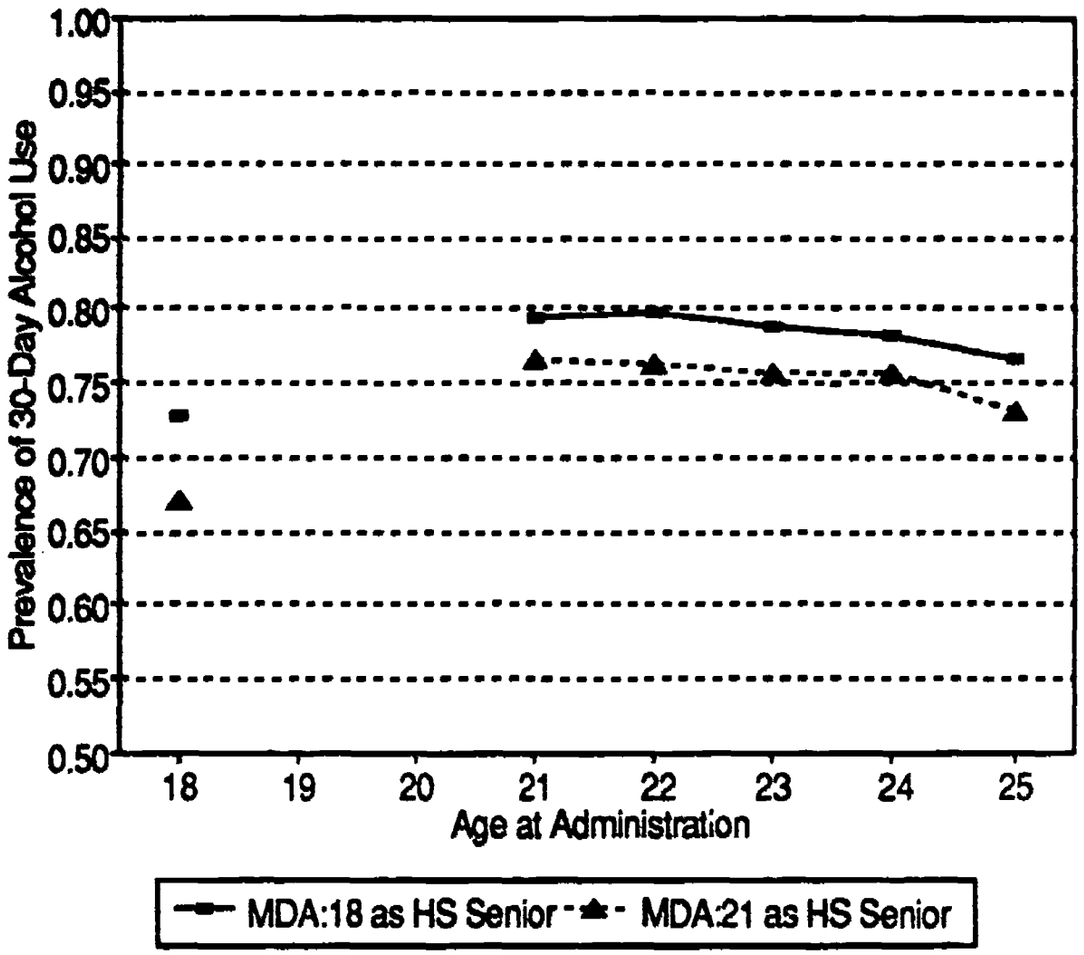


Figure 14

Prevalence of Heavy Drinking (Last 2 Weeks) by Age and Minimum Drinking Age

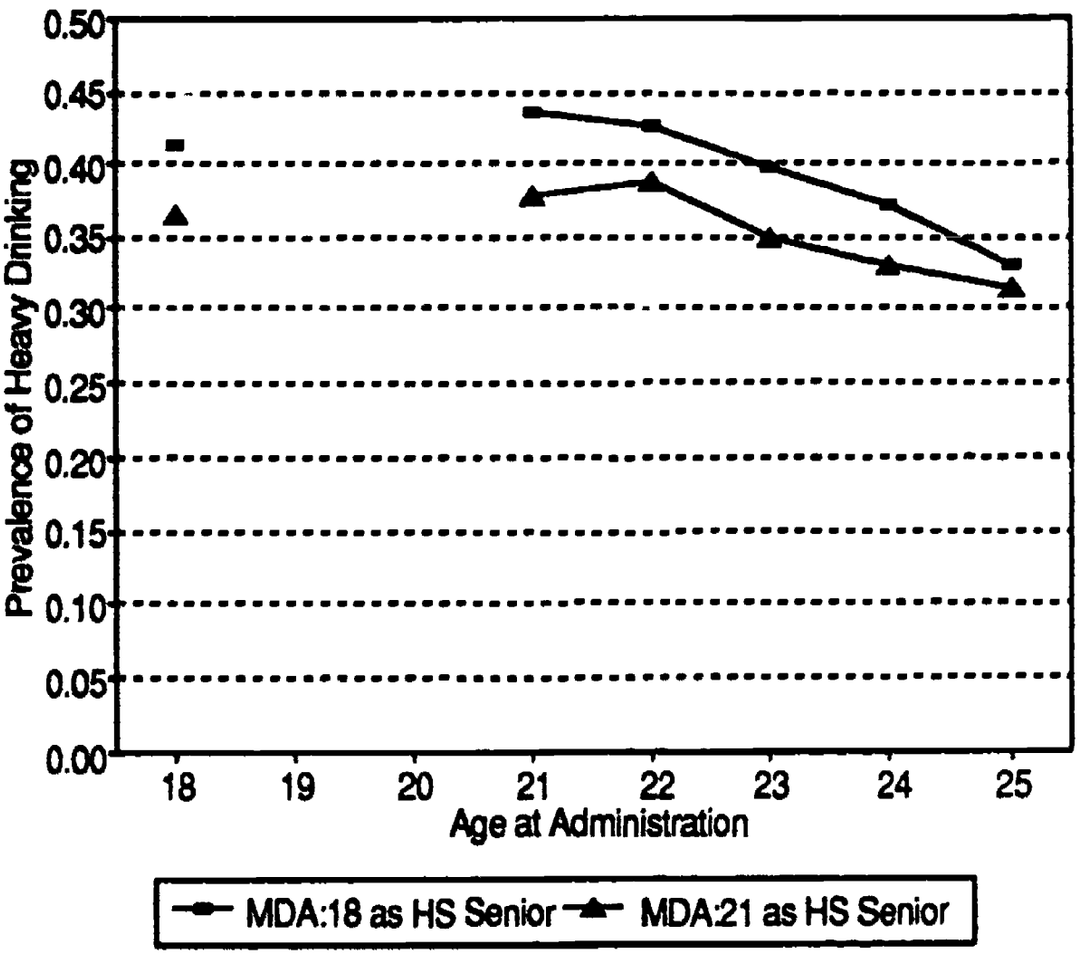


Figure 15

Alcohol Use (30-Day Mean) Before and After Change

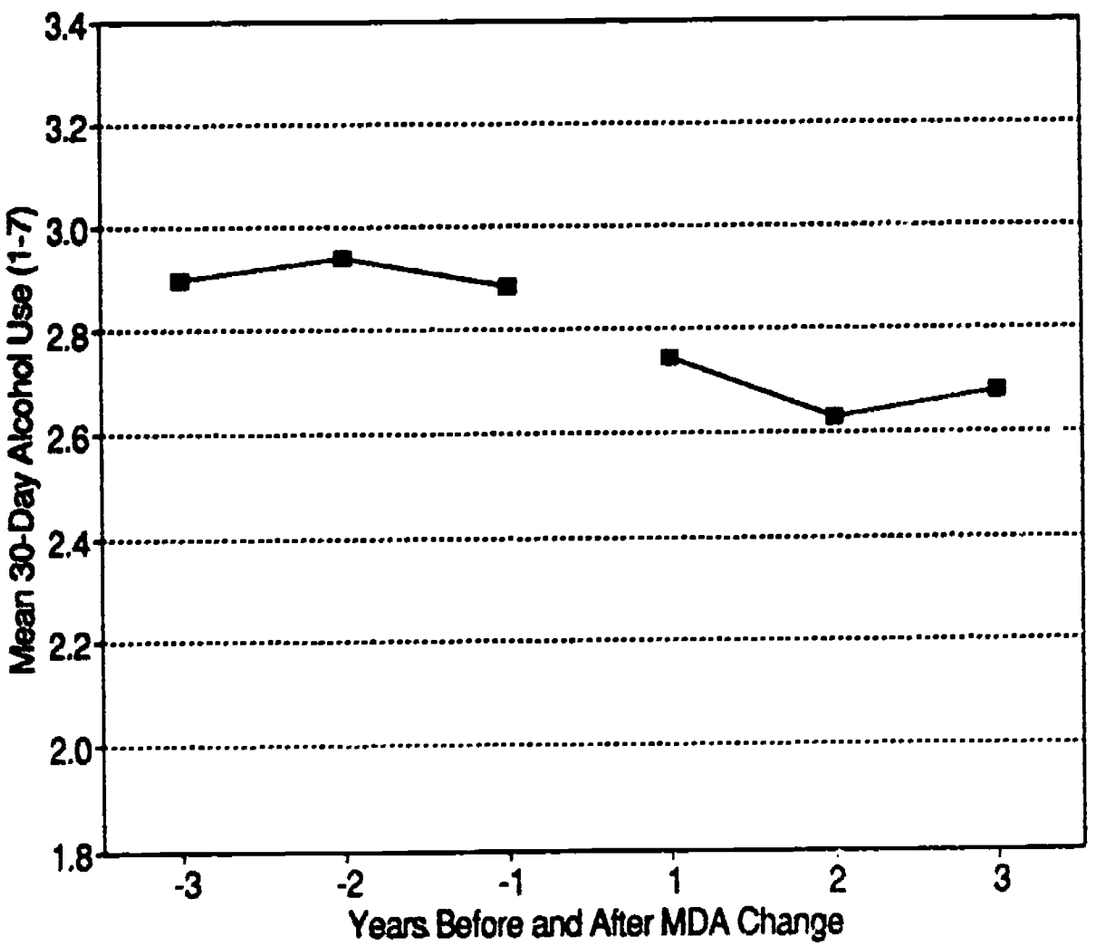


Figure 16

Alcohol Use (Heavy Drinking Mean) Before and After Change

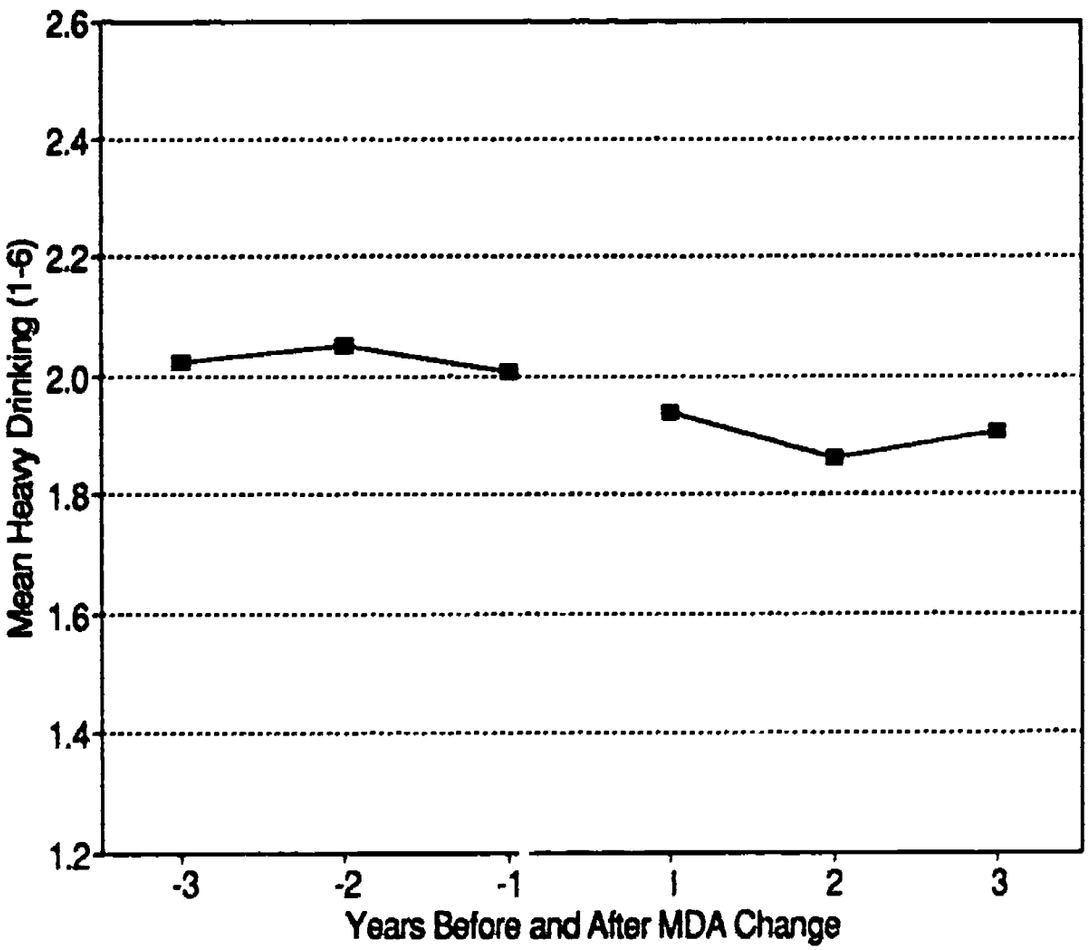


Figure 17

Prevalence of 30-Day Alcohol Use Before and After Change

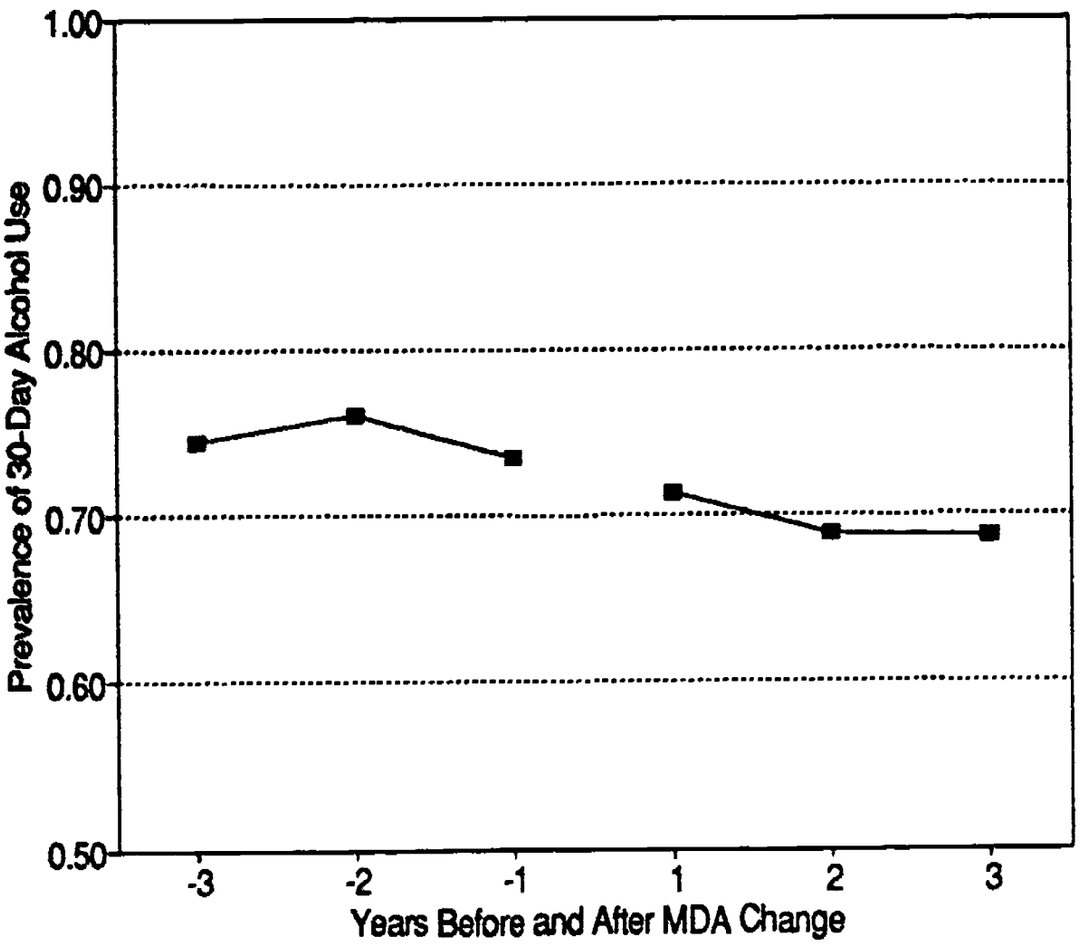


Figure 18

Prevalence of Heavy Drinking (Last 2 Weeks) Before and After Change

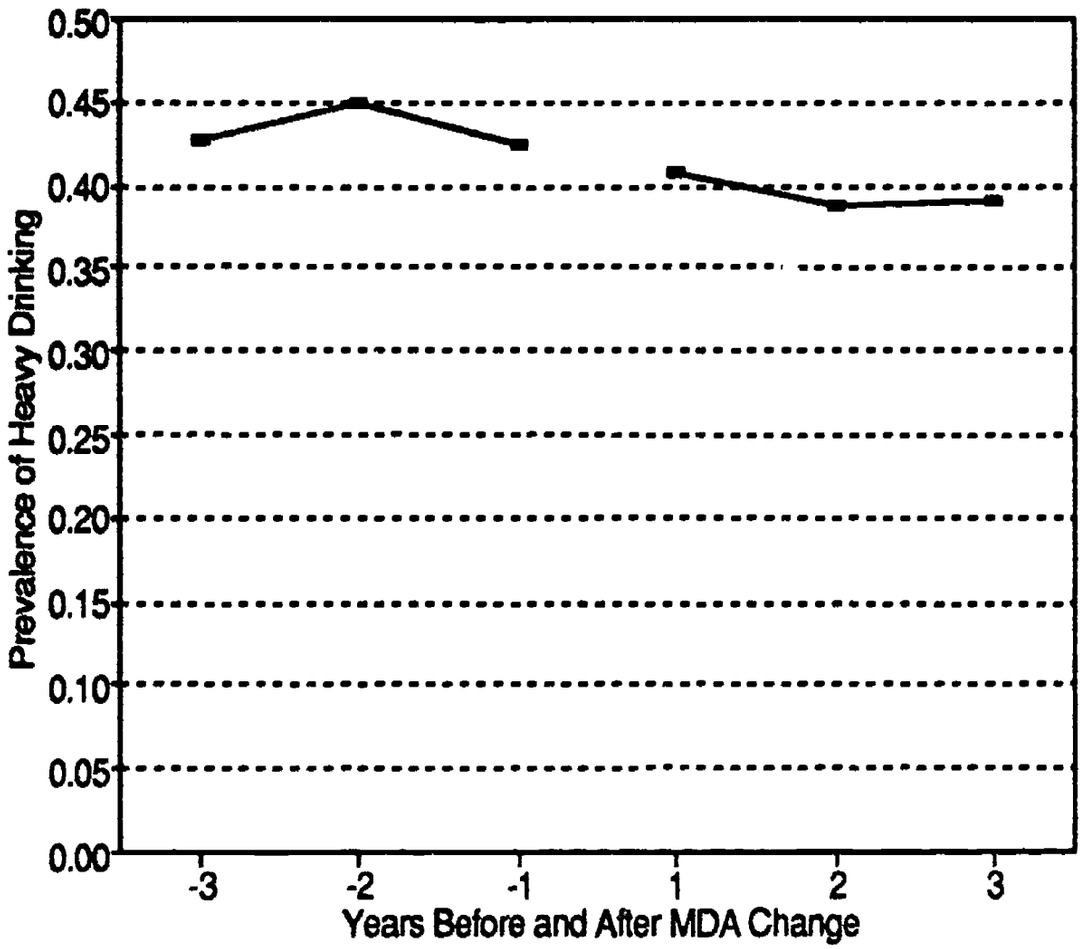


Figure 19

Percent Change in Fatal Crashes by Type of Law Change
(Fatal Accident Reporting System Data)

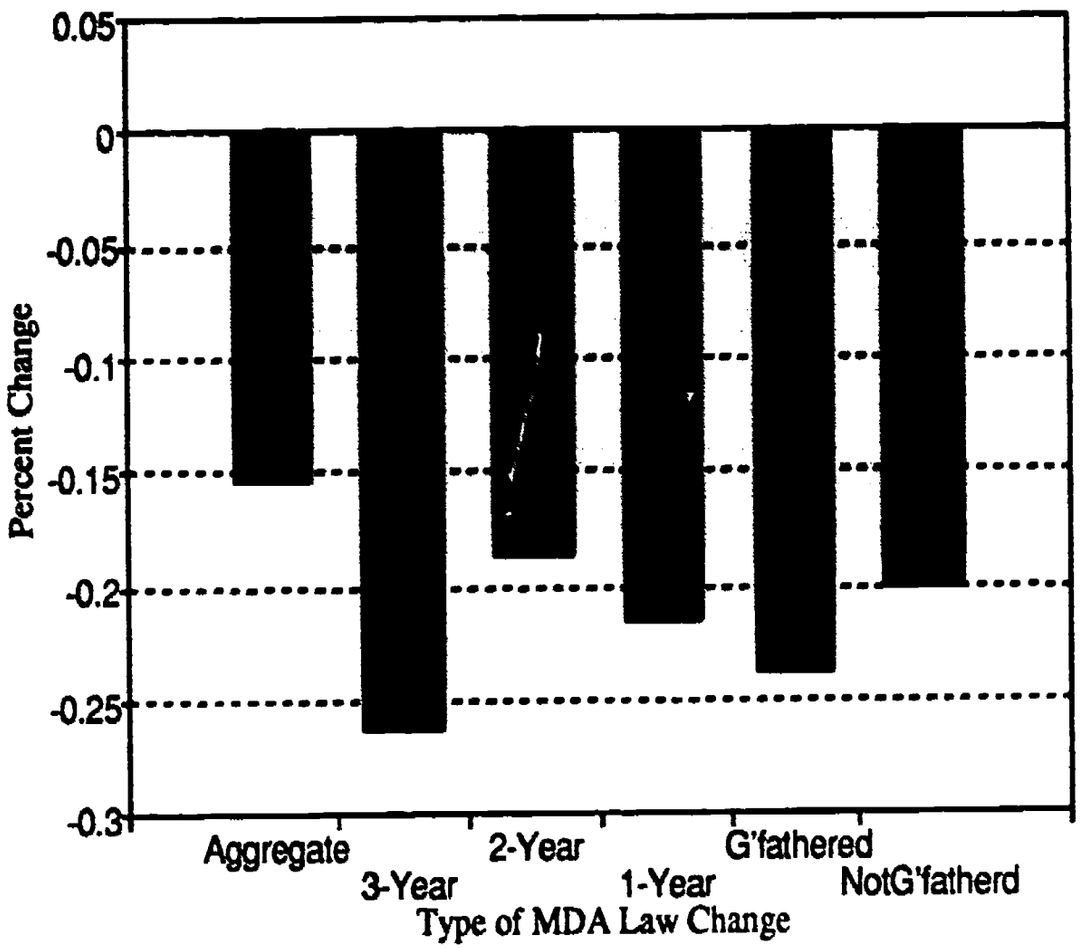
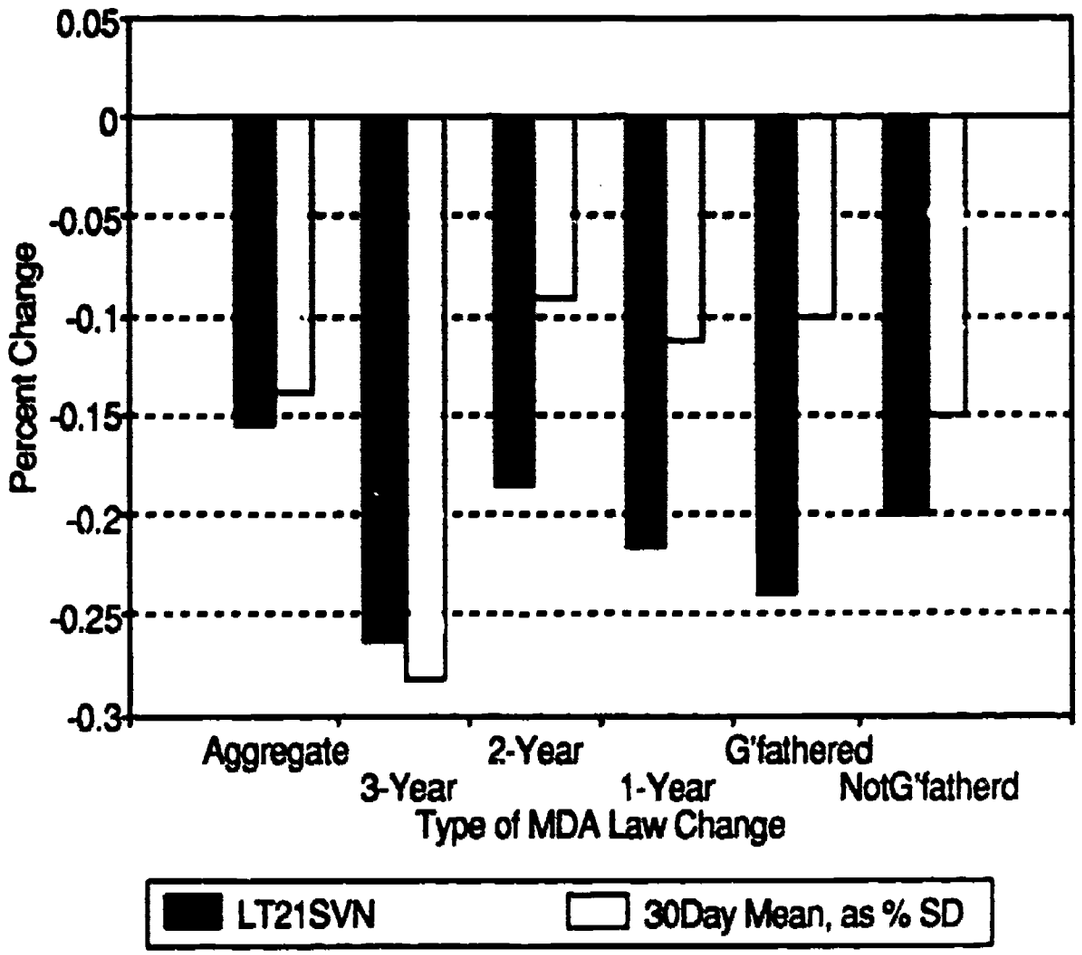


Figure 20

Percent Change in Fatal Crashes and Alcohol Use by Type of Law Change (Fatal Accident Reporting System Data and Self-Report Data)



Appendix A

LIST OF APPENDIX A TABLES

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Table A-1
Effective Dates of Changes in Minimum Drinking Ages by States, 1976–1987

State	Type of Change	Effective Date	Comments
Alabama	19–21	10/1/85	G
Arizona	19–21	1/1/85	G
Connecticut	18–19	7/1/82	
Connecticut	19–20	10/1/83	
Connecticut	20–21	9/1/85	G
Delaware	20–21	1/1/84	G
Florida	18–19	10/1/80	
Florida	19–21	7/1/85	G
Georgia	18–19	9/1/80	
Georgia	19–20	9/30/85	
Georgia	20–21	9/30/86	
Illinois	19–21	1/1/80	Beer&Wine
Iowa	18–19	7/1/78	G
Iowa	19–21	9/1/86	G
Kansas	18–21	7/1/85	G, Beer
Maine	18–20	10/24/77	
Maine	20–21	7/1/85	G
Maryland	18–21	7/1/82	G, Beer&Wine
Massachusetts	18–20	4/16/79	
Massachusetts	20–21	6/1/85	G
Michigan	18–21	12/21/78	
Minnesota	18–19	9/1/76	G
Minnesota	19–21	9/1/86	G
Mississippi	18–21	10/1/86	Beer&Wine
Montana	18–19	1/1/79	
Nebraska	19–20	7/19/80	G
Nebraska	20–21	1/1/85	G
New Hampshire	18–20	5/24/79	
New Hampshire	20–21	6/1/85	G
New Jersey	18–19	1/2/80	G
New Jersey	19–21	1/1/83	G
New York	18–19	12/4/82	
New York	19–21	12/1/85	
North Carolina	18–19	10/1/83	Beer&Wine
North Carolina	19–21	9/1/86	
Ohio	18–19	8/19/82	Beer
Ohio	19–21	7/31/87	G, Beer
Oklahoma	18–21	9/22/83	Beer

Table A-1
Effective Dates of Changes in Minimum Drinking Ages by States, 1976-1987
(Continued)

State	Type of Change	Effective Date	Comments
Rhode Island	18-19	7/1/80	
Rhode Island	19-20	7/1/81	
Rhode Island	20-21	7/1/84	
South Carolina	18-19	1/1/84	Beer&Wine
South Carolina	19-20	1/1/85	Beer&Wine
South Carolina	20-21	9/14/86	Beer&Wine
South Dakota	18-19	7/1/84	Beer
Tennessee	18-19	6/1/79	
Tennessee	19-21	8/1/84	G
Texas	18-19	9/1/81	
Texas	19-21	9/1/86	
Vermont	18-21	7/1/86	G
Virginia	18-19	7/1/81	Beer
Virginia	19-21	7/1/85	G
Virginia	20-21	7/1/87	
West Virginia	18-19	7/1/83	
West Virginia	19-21	7/1/86	
WashingtonDC	18-21	9/1/86	G, Beer&Wine
Wisconsin	18-19	7/1/84	
Wisconsin	19-21	9/1/86	G

Note: G = Grandfather clause included.

The following sources of information were used:

Bonnie, R.J. (1985). Regulating conditions of alcohol availability: Possible effects on highway safety. *Journal of Studies on Alcohol, Supp. No. 10*, 129-147.

Distilled Spirits Council of the United States. (1981, 1983, 1985). *Summary of state laws and regulations relating to distilled spirits.* Washington, D.C.: Author.

DuMouchel, W., Williams, A.F., & Zador, P. (1987). Raising the alcohol purchase age: Its effects on fatal motor vehicle crashes in twenty-six states. *Journal of Legal Studies, 16*, 249-266.

Insurance Information Institute. (1983, 1984, 1985). *Insurance Facts.* New York: Author.

National Safety Council. (September 20, 1985). *Policy update.* Chicago, Ill.: Author.

Wagenaar, A.C. (1983). *Alcohol, young drivers, and traffic accidents: Effects of minimum-age laws.* Lexington, Mass.: D.C. Heath and Co., 1983.

Table A-2

Alcohol Use by Minimum Drinking Age Category
States with Constant Minimum Drinking Age: 1976–1981

Minimum Drinking Age	Year of Administration						1976–1981 Combined		
	1976	1977	1978	1979	1980	1981	N	Mean	StDev
Mean 30-Day Alcohol Use									
18 (Some)	2.700	2.761	2.820	2.946	2.932	2.898	38650	2.834	1.623
19–20	2.259	2.378	2.668	2.510	2.466	2.599	3876	2.488	1.512
21 (All)	2.532	2.607	2.503	2.586	2.688	2.728	31102	2.605	1.584
Total	2.604	2.675	2.704	2.769	2.793	2.802	73628	2.719	1.606
Mean Heavy Drinking									
18 (Some)	1.883	1.930	1.942	2.021	2.041	2.069	38398	1.973	1.379
19–20	1.564	1.631	1.857	1.779	1.745	1.845	3871	1.743	1.220
21 (All)	1.785	1.850	1.768	1.870	1.920	1.979	30951	1.859	1.335
Total	1.824	1.880	1.878	1.943	1.968	2.013	73220	1.913	1.354
Prevalence of 30-Day Alcohol Use									
18 (Some)	0.690	0.719	0.729	0.750	0.752	0.741	38650	0.729	0.445
19–20	0.576	0.609	0.713	0.637	0.660	0.680	3876	0.648	0.478
21 (All)	0.656	0.674	0.646	0.669	0.691	0.687	31102	0.670	0.470
Total	0.670	0.694	0.699	0.709	0.719	0.713	73628	0.700	0.458
Prevalence of Heavy Drinking									
18 (Some)	0.378	0.398	0.406	0.431	0.437	0.439	38398	0.413	0.492
19–20	0.279	0.287	0.396	0.338	0.335	0.390	3871	0.340	0.474
21 (All)	0.345	0.360	0.334	0.372	0.393	0.406	30951	0.367	0.482
Total	0.359	0.376	0.381	0.401	0.411	0.421	73220	0.390	0.488

Table A-3
Alcohol Use by Minimum Drinking Age Category 1976–1987

Minimum Drinking Age	Year of Administration												Total
	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	
Numbers of cases													
18/Sometime	10637	12313	15048	9861	9409	9823	9449	9298	9502	9550	8547	10214	123651
Other	1220	1458	1717	1664	1442	1740	1721	1543	1776	1467	1524	1738	19010
Constant 21	5571	6200	5352	4086	4671	5222	5997	5104	4250	4499	4758	4026	59736
Mean 30-Day Alcohol Use													
18/Sometime	2.779	2.878	2.888	2.944	2.888	2.817	2.765	2.745	2.640	2.588	2.551	2.567	2.764
Other	2.411	2.557	2.932	2.924	2.756	2.680	2.743	2.593	2.485	2.511	2.406	2.364	2.620
Constant 21	2.532	2.607	2.503	2.586	2.688	2.728	2.650	2.588	2.507	2.510	2.518	2.496	2.580
Mean Heavy Drinking													
18/Sometime	1.926	1.996	1.966	2.020	2.018	2.009	1.978	1.987	1.891	1.864	1.841	1.857	1.948
Other	1.671	1.734	2.011	2.057	1.961	1.912	1.952	1.921	1.850	1.837	1.684	1.712	1.864
Constant 21	1.785	1.850	1.768	1.870	1.920	1.979	1.941	1.897	1.843	1.848	1.845	1.838	1.866
Prevalence of 30-Day Alcohol Use													
18/Sometime	0.715	0.748	0.747	0.757	0.748	0.730	0.711	0.708	0.687	0.677	0.656	0.670	0.715
Other	0.634	0.665	0.768	0.734	0.708	0.697	0.701	0.673	0.653	0.654	0.619	0.634	0.680
Constant 21	0.656	0.674	0.646	0.669	0.691	0.687	0.693	0.671	0.646	0.652	0.646	0.659	0.667
Prevalence of Heavy Drinking													
18/Sometime	0.397	0.421	0.418	0.435	0.431	0.428	0.421	0.419	0.393	0.373	0.368	0.374	0.407
Other	0.300	0.317	0.433	0.431	0.397	0.396	0.398	0.410	0.374	0.372	0.321	0.328	0.375
Constant 21	0.345	0.360	0.334	0.372	0.393	0.406	0.402	0.389	0.369	0.371	0.367	0.371	0.373

Table A-4

Alcohol Use by Student Status at Follow-Up
by Minimum Drinking Age Category at Base-Year
1980–1987

Student Status	Minimum Drinking Age	Year of Follow-Up Survey								Average Wtd. N per Year
		1980	1981	1982	1983	1984	1985	1986	1987	
Mean 30-Day Alcohol Use										
College	18 at BY	3.289	3.115	3.241	3.148	3.109	3.127	3.082	3.072	706
College	21 at BY	2.807	2.902	2.849	2.916	3.011	2.862	3.017	2.896	312
NonCollege	18 at BY	3.043	3.064	3.048	2.931	2.887	2.780	2.770	2.747	988
NonCollege	21 at BY	2.880	2.828	2.826	2.731	2.772	2.695	2.762	2.687	476

Table A-5
Alcohol Use at Ages 21–25 by Minimum Drinking Age Category at Base-Year 1979–1987

Minimum Drinking Age at Base-Year	Age at Follow-Up Survey					Combined 21–25
	21	22	23	24	25	
Weighted Number of Cases						
18 at BY	1921	1941	1885	1905	1786	9438
21 at BY	1265	1224	1279	1203	1223	6195
Mean 30-Day Alcohol Use						
18 at BY	3.111	3.149	3.088	3.092	2.969	3.083
21 at BY	2.945	2.953	2.958	2.900	2.847	2.921
Mean Heavy Drinking						
18 at BY	1.960	1.942	1.838	1.802	1.674	1.846
21 at BY	1.805	1.837	1.774	1.700	1.633	1.751
Prevalence of 30-Day Alcohol Use						
18 at BY	0.796	0.799	0.790	0.784	0.766	0.787
21 at BY	0.768	0.764	0.758	0.756	0.733	0.756
Prevalence of Heavy Drinking						
18 at BY	0.437	0.427	0.396	0.372	0.332	0.394
21 at BY	0.378	0.387	0.351	0.330	0.314	0.352
Standard Deviation: 30-Day Alcohol Use						
18 at BY	1.654	1.644	1.630	1.659	1.593	1.638
21 at BY	1.587	1.617	1.611	1.602	1.603	1.604
Standard Deviation: Heavy Drinking						
18 at BY	1.311	1.311	1.236	1.239	1.141	1.255
21 at BY	1.214	1.253	1.230	1.167	1.102	1.197
Standard Deviation: Prevalence of 30-Day Alcohol Use						
18 at BY	0.403	0.401	0.407	0.411	0.424	0.409
21 at BY	0.422	0.424	0.428	0.430	0.443	0.430
Standard Deviation: Prevalence of Heavy Drinking						
18 at BY	0.496	0.495	0.489	0.483	0.471	0.489
21 at BY	0.485	0.487	0.477	0.470	0.464	0.478

Table A-6

Alcohol Use Before and After Changes in Minimum Drinking Age Category Changes from 18 to 19, 20, or 21

Minimum Drinking Age Change	Measure	Years Before and After Change						Combined	
		−3	−2	−1	1	2	3	Bef	After
30-Day Alcohol Use (1–7)									
18 to 19									
	Mean	2.891	2.887	2.732	2.688	2.594	2.644	2.833	2.644
	Stan.Dev.	1.658	1.631	1.632	1.609	1.565	1.614	1.641	1.597
	N	5825	6294	6736	6391	5514	5313	18855	17218
18 to 20									
	Mean	3.099	3.086	3.239	2.983	3.121	3.069	3.158	3.039
	Stan.Dev.	1.545	1.546	1.593	1.551	1.552	1.635	1.569	1.577
	N	403	1417	1533	1499	697	948	3353	3144
18 to 21									
	Mean	2.875	3.082	3.252	2.773	2.501	2.525	3.079	2.624
	Stan.Dev.	1.594	1.671	1.676	1.56	1.505	1.544	1.655	1.545
	N	1140	956	1328	1598	1023	1137	3424	3758
18 to 19,20, or 21									
	Mean	2.9	2.941	2.885	2.749	2.632	2.68	2.908	2.693
	Stan.Dev.	1.643	1.624	1.648	1.595	1.564	1.613	1.639	1.592
	N	7368	8667	9597	9488	7234	7398	25632	24120
Heavy Drinking (2-Weeks, 1–6)									
18 to 19									
	Mean	2.025	2.012	1.914	1.907	1.852	1.867	1.981	1.877
	Stan.Dev.	1.42	1.397	1.358	1.336	1.284	1.335	1.391	1.32
	N	5785	6263	6715	6342	5476	5289	18763	17107
18 to 20									
	Mean	2.18	2.166	2.249	2.108	2.179	2.256	2.205	2.169
	Stan.Dev.	1.424	1.402	1.483	1.392	1.375	1.468	1.442	1.412
	N	401	1413	1521	1467	697	930	3335	3094
18 to 21									
	Mean	1.965	2.173	2.201	1.908	1.702	1.799	2.115	1.819
	Stan.Dev.	1.364	1.477	1.511	1.315	1.186	1.265	1.458	1.269
	N	1125	960	1322	1601	1018	1127	3407	3746
18 to 19,20, or 21									
	Mean	2.024	2.055	2.007	1.939	1.863	1.906	2.028	1.906
	Stan.Dev.	1.412	1.409	1.408	1.343	1.285	1.349	1.409	1.328
	N	7311	8636	9558	9410	7191	7346	25505	23947

Table A-6
Alcohol Use Before and After Changes in Minimum Drinking Age Category
Changes from 18 to 19, 20, or 21
(Continued)

Minimum Drinking Age Change	Measure	Years Before and After Change						Combined	
		−3	−2	−1	1	2	3	Bef	After
Prevalence of 30-Day Alcohol Use									
18 to 19									
	Mean	0.735	0.743	0.697	0.691	0.677	0.676	0.724	0.682
	Stan.Dev.	0.441	0.437	0.460	0.462	0.468	0.468	0.447	0.466
	N	5825	6294	6736	6391	5514	5313	18855	17218
18 to 20									
	Mean	0.841	0.827	0.832	0.789	0.831	0.785	0.831	0.797
	Stan.Dev.	0.366	0.378	0.374	0.408	0.375	0.411	0.375	0.402
	N	403	1417	1533	1499	697	948	3353	3144
18 to 21									
	Mean	0.761	0.781	0.822	0.738	0.661	0.654	0.790	0.692
	Stan.Dev.	0.427	0.414	0.382	0.440	0.474	0.476	0.407	0.462
	N	1140	956	1328	1598	1023	1137	3424	3758
18 to 19,20, or 21									
	Mean	0.745	0.761	0.736	0.714	0.689	0.687	0.747	0.698
	Stan.Dev.	0.436	0.426	0.441	0.452	0.463	0.464	0.435	0.459
	N	7368	8667	9597	9488	7234	7398	25632	24120
Prevalence of Heavy Drinking									
18 to 19									
	Mean	0.424	0.431	0.393	0.392	0.381	0.375	0.415	0.383
	Stan.Dev.	0.494	0.495	0.489	0.488	0.486	0.484	0.493	0.486
	N	5785	6263	6715	6342	5476	5289	18763	17107
18 to 20									
	Mean	0.511	0.505	0.506	0.479	0.521	0.519	0.506	0.501
	Stan.Dev.	0.500	0.500	0.500	0.500	0.500	0.500	0.500	0.500
	N	401	1413	1521	1467	697	930	3335	3094
18 to 21									
	Mean	0.415	0.482	0.481	0.404	0.326	0.350	0.460	0.367
	Stan.Dev.	0.493	0.500	0.500	0.491	0.469	0.477	0.498	0.482
	N	1125	960	1322	1601	1018	1127	3407	3746
18 to 19,20, or 21									
	Mean	0.427	0.449	0.423	0.408	0.387	0.389	0.433	0.396
	Stan.Dev.	0.495	0.497	0.494	0.491	0.487	0.488	0.495	0.489
	N	7311	8636	9558	9410	7191	7346	25505	23947

Table A-7

Alcohol Use Before and After Change in Minimum Drinking Age Category: FARS States Only

Change Type	Measure	3 Years Before	3 Years After	Total	% SD Change
30-Day Alcohol Use (1–7)					
1-Year	Mean	2.802	2.619	2.709	−11.4%
	Stan.Dev.	1.630	1.585	1.610	
	N	11164	11564	22728	
2-Year	Mean	3.061	2.914	2.991	−9.1%
	Stan.Dev.	1.606	1.640	1.624	
	N	6512	5976	12488	
3-Year	Mean	3.079	2.624	2.841	−28.2%
	Stan.Dev.	1.655	1.545	1.614	
	N	3424	3758	7182	
G'Fathered	Mean	2.970	2.812	2.891	−10.0%
	Stan.Dev.	1.599	1.563	1.583	
	N	4986	5028	10014	
Not G'Fathered	Mean	2.914	2.669	2.791	−15.0%
	Stan.Dev.	1.642	1.609	1.630	
	N	16114	16270	32384	
Aggregate	Mean	2.927	2.703	2.814	−13.8%
	Stan.Dev.	1.632	1.599	1.619	
	N	21100	21298	42398	
Heavy Drinking (1–6)					
1-Year	Mean	1.945	1.873	1.908	−5.3%
	Stan.Dev.	1.378	1.315	1.347	
2-Year	Mean	2.117	2.080	2.099	−2.6%
	Stan.Dev.	1.426	1.436	1.431	
3-Year	Mean	2.115	1.819	1.960	−21.6%
	Stan.Dev.	1.458	1.269	1.370	
G'Fathered	Mean	2.005	1.957	1.981	−3.5%
	Stan.Dev.	1.375	1.347	1.361	
Not G'Fathered	Mean	2.032	1.910	1.971	−8.8%
	Stan.Dev.	1.419	1.345	1.384	
Aggregate	Mean	2.026	1.921	1.973	−7.6%
	Stan.Dev.	1.409	1.346	1.378	

Table A-7 (Continued)

Alcohol Use Before and After Change in Minimum Drinking Age Category: FARS States Only

Change Type	Measure	3 Years Before	3 Years After	Total	% SD Change
Prevalence of 30-Day Alcohol Use					
1-Year	Mean	0.720	0.678	0.699	−9.2%
	Stan.Dev.	0.449	0.467	0.459	
	N	11164	11564	22728	
2-Year	Mean	0.797	0.756	0.777	−9.9%
	Stan.Dev.	0.402	0.430	0.416	
	N	6512	5976	12488	
3-Year	Mean	0.790	0.692	0.739	−22.3%
	Stan.Dev.	0.407	0.462	0.439	
	N	3424	3758	7182	
G'Fathered	Mean	0.774	0.748	0.761	−6.1%
	Stan.Dev.	0.419	0.434	0.427	
	N	4986	5028	10014	
Not G'Fathered	Mean	0.749	0.688	0.718	−13.6%
	Stan.Dev.	0.434	0.463	0.450	
	N	16114	16270	32384	
Aggregate	Mean	0.755	0.702	0.729	−11.9%
	Stan.Dev.	0.430	0.457	0.445	
	N	21100	21298	42398	
Prevalence of Heavy Drinking					
1-Year	Mean	0.402	0.384	0.393	−3.7%
	Stan.Dev.	0.490	0.486	0.488	
2-Year	Mean	0.470	0.448	0.459	−4.4%
	Stan.Dev.	0.499	0.497	0.498	
3-Year	Mean	0.460	0.367	0.411	−18.9%
	Stan.Dev.	0.498	0.482	0.492	
G'Fathered	Mean	0.438	0.422	0.430	−3.2%
	Stan.Dev.	0.496	0.494	0.495	
Not G'Fathered	Mean	0.431	0.391	0.411	−8.1%
	Stan.Dev.	0.495	0.488	0.492	
Aggregate	Mean	0.432	0.399	0.415	−6.7%
	Stan.Dev.	0.495	0.490	0.493	

Appendix B

This appendix provides question wordings and response scales for the various measures referred to in text. Measures are grouped according to the following categories:

A. Alcohol use measures
B. Grade of first use of alcohol.
C. Degree and duration of intoxication
D. Attitudes toward drinking
E. Exposure to drinking
F. Circumstances or setting of alcohol use
G. Reasons for drinking
H. Driving violations and traffic crashes following use of alcohol
I. Use of other psychoactive substances
J. Delinquent behaviors and victimization experiences
K. Truancy
L. Leisure time activities
M. Background and demographic variables

A. Alcohol use measures

On how many occasions have you had alcoholic beverages to drink..

...in your lifetime?
...during the last 12 months?
...during the last 30 days?

1. 0 occasions; 2. 1-2; 3. 3-5; 4. 6-9; 5. 10-19; 6. 20-39; 7. 40 or more

Think back over the LAST TWO WEEKS. How many times have you had five or more drinks in a row? (A "drink" is a glass of wine, a bottle of beer, a shot glass of liquor, or a mixed drink.)

1. None; 2. Once; 3. Twice; 4. Three to five times; 5. Six to nine times;
6. Ten or more times

B. Grade of first use of alcohol

When (if ever) did you FIRST try an alcoholic beverage – more than just a few sips...

8. Never; 1. Grade 6 or below; 2. Grade 7 or 8; 3. Grade 9 (Freshman);
4. Grade 10 (Sophomore); 5. Grade 11 (Junior); 6. Grade 12 (Senior)

C. Degree and duration of intoxication

When you drink alcoholic beverages, how high do you usually get?

1. Not at all high; 2. A little high; 3. Moderately high; 4. Very high

When you drink alcoholic beverages, how long do you usually stay high?

1. Usually don't get high; 2. One to two hours; 3. Three to six hours;
4. Seven to 24 hours; 5. More than 24 hours

D. Attitudes toward drinking (respondents own and friends')

How much do you think people risk harming themselves if they...

Try one or two drinks of an alcoholic beverage (beer, wine, liquor)
Take one or two drinks nearly every day
Take four or five drinks nearly every day
Have five or more drinks once or twice each weekend

1. No risk; 2. Slight risk; 3. Moderate risk; 4. Great risk;
5. Can't say, drug unfamiliar

Do you disapprove of people (who are 18 or older) doing each of the following?

Trying one or two drinks of an alcoholic beverage (beer,wine, liquor)
Taking one or two drinks nearly every day
Taking four or five drinks nearly every day
Having five or more drinks once or twice each weekend

1. Don't disapprove; 2. Disapprove; 3. Strongly disapprove

How do you think your CLOSE FRIENDS feel (or would feel) about YOU doing each of the following things?

Taking one or two drinks nearly every day
Taking four or five drinks nearly every day
Having five or more drinks once or twice each weekend

1. Not disapprove; 2. Disapprove; 3. Strongly disapprove

Do you think that people (who are 18 or older) should be prohibited by law from doing each of the following?

Getting drunk in private
Getting drunk in public places

1. No; 2. Not sure; 3. Yes

E. Exposure to drinking

How many of your friends would you estimate...

Drink alcoholic beverages (liquor, beer, wine)?
Get drunk at least once a week?

1. None; 2. A few; 3. Some; 4. Most; 5. All

During the LAST 12 MONTHS, how often have you been around people who were taking each of the following to get high or for "kicks"?

Alcoholic beverages (beer, wine, liquor)

1. Not at all; 2. Once or twice; 3. Occasionally; 4. Often

F. Circumstances or setting of alcohol use

When you used alcohol during the last year, how often did you use it in each of the following situations?

When you were alone
With just 1 or 2 other people
At a party
When your date or spouse was present
When people over age 30 were present
During the daytime (before 4:00 p.m.)
At your home (or apartment or dorm
At school
In a car

1. Not at all; 2. A few of the times; 3. Some of the times; 4. Most of the times; 5. Every time

G. Reasons for drinking

What have been the most important reasons for your drinking alcoholic beverages?

To experiment—to see what it's like
To relax or relieve tension
To feel good or get high
To seek deeper insights and understanding
To have a good time with my friends
To fit in with a group I like
To get away from my problems or troubles
Because of boredom, nothing else to do
Because of anger or frustration
To get through the day
To increase the effects of some other drug(s)
To decrease (offset) the effects of some other drug(s)
To get to sleep
Because it tastes good
Because I am "hooked"—I feel I have to drink

H. Driving violations and traffic crashes following use of alcohol

Within the LAST 12 MONTHS, how many times, if any, have you received a ticket (OR been stopped and warned) for moving violations, such as speeding, running a stop light, or improper passing?

0. None; 1. Once; 2. Twice; 3. Three times; 4. Four or more times

How many of these tickets or warnings occurred after you were...

Drinking alcoholic beverages?

0. None; 1. One; 2. Two; 3. Three; 4. Four or more

During the LAST 12 MONTHS, how many accidents have you had while you were driving (whether or not you were responsible)?

0. None; 1. One; 2. Two; 3. Three; 4. Four or more

How many of these accidents occurred after you were ...

Drinking alcoholic beverages?

0. None; 1. One; 2. Two; 3. Three; 4. Four or more

I. Use of other psychoactive substances

On how many occasions (if any) have you had marijuana (grass, pot) or hashish (hash, hash oil)...

1. 0 occasions; 2. 1-2; 3. 3-5; 4. 6-9; 5. 10-19; 6. 20-39; 7. 40 or more

J. Delinquent behaviors and victimization experiences

During the LAST 12 months, how often have you...

Argued or had a fight with either of your parents
Hit an instructor or supervisor
Gotten into a serious fight in school or at work
Taken part in a fight where a group of your friends were against another group
Hurt someone badly enough to need bandages or a doctor
Used a knife or gun or some other thing (like a club) to get something from a person
Taken something not belonging to you worth under $50
Taken something not belonging to you worth over $50
Taken something from a store without paying for it
Taken a car that didn't belong to someone in your family without permission of the owner
Taken part of a car without permission of the owner
Gone into some house or building when you weren't supposed to be there
Set fire to someone's property on purpose
Damaged school property on purpose
Damaged property at work on purpose
Gotten into trouble with police because of something you did

1. Not at all; 2. Once; 3. Twice; 4. 3 or 4 times; 5. 5 or more times

During the LAST 12 MONTHS, how often...

Has something of yours (worth under $50) been stolen?
Has something of yours (worth over $50) been stolen?
Has someone deliberately damaged your property (your car, clothing, etc.)?
Has someone injured you with a weapon (like a knife, gun, or club)?
Has someone threatened you with a weapon, but not actually injured you?
Has someone injured you on purpose without using a weapon?
Has an unarmed person threatened you with injury, but not actually injured you?

1. Not at all; 2. Once; 3. Twice; 4. 3 or 4 times; 5. 5 or more times

K. Truancy

During the LAST FOUR WEEKS, how many whole days of school have you missed...

...Because of illness
...Because you skipped or "cut"
...For other reasons

1. None; 2. 1 day; 3. 2 days; 4. 3 days; 5. 4-5 days; 6. 6-10 days; 7. 11 or more

During the last four weeks, how often have you gone to school, but skipped a class when you weren't supposed to?

1. Not at all; 2. 1 or 2 times; 3. 3-5 times; 4. 6-10 times; 5. 11-20 times;
6. More than 20 times

L. Leisure time activities

How often do you do each of the following?

Watch TV
Go to movies
Attend art shows, musical performances, or theater plays
Ride around in a car (or motorcycle) just for fun
Participate in community affairs or volunteer work
Play a musical instrument or sing
Do creative writing
Actively participate in sports, athletics or exercising
Do art or craft work
Work around the house, yard, garden, car, etc.
Get together with friends, informally
Go shopping or window-shopping
Spend at least an hour of leisure time alone
Read books, magazines, or newspapers
Go to taverns, bars or nightclubs
Go to parties or other social affairs

5. Almost everyday; 4. At least once a week; 3. Once or twice a month;
2. A few times a year; 1. Never

M. Background and demographic characteristics

How would you describe your political beliefs?

1. Very conservative; 2. Conservative; 3. Moderate; 4. Liberal; 5. Very liberal;
6. Radical; 8. None of the above, or don't know

How often do you attend religious services?

1. Never; 2. Rarely; 3. Once or twice a month; 4. About once a week or more

How important is religion in your life?

1. Not important; 2. A little important; 3. Pretty important; 4. Very important

Which of the following best describes your average grade so far in high school?

9. A (93-100); 8. A- (90-92); 7. B+ (87-89); 6. B (83-86); 5. B- (80-82);
4. C+ (77-79); 3. C (73-76), 2. C- (70-72); 1. D (69 or below)

During an average week, how much do you usually drive a car, truck, or motorcycle?

1. Not at all; 2. 1 to 10 miles; 3. 11 to 50 miles; 4. 51 to 100 miles;
5. 100 to 200 miles; 6. More than 200 miles

Appendix C

Fatal Accident Reporting System (FARS) Analyses

by

Alexander C. Wagenaar

Fredrick M. Streff

Robert H. Schultz

The University of Michigan
Transportation Research Institute

Appendix C

Methods

Research Design

A monthly time-series design was used to control for numerous factors known to influence the number of motor vehicle crash fatalities evident in multi-year trends, cycles, and other patterns. Analyses of the effects of changes in minimum-drinking-age laws were based on fatality data from three years prior to and three years following each change. Thus, actual time periods covered for each state included in this study differed since law changes were enacted at different times. However, time-series models for each state were based on three-year pre- and post-change periods.

Data were collapsed into groups based on whether or not a law had a grandfather clause and by the number of years the minimum drinking age was increased. A law containing a grandfather clause would not remove the right to purchase alcoholic beverages from those individuals who were of age to make such purchases prior to the effective data of the law. Changes in minimum drinking age included one-, two-, and three-year increases. Twenty-four time-series models were examined: two law clauses (grandfathered vs. nongrandfathered), times 3 age changes (1-year, 2-year, vs. 3-year), times 2 age groups (drivers the focus of the new laws vs. drivers age 21 and over), times 2 crash types (single-vehicle nighttime vs. daytime). The particular states with Grandfather clauses are: New Jersey, Nebraska, and Delaware (1-year increase); New Jersey (2-year increase); Maryland (3-year increase). New Jersey is included twice because its drinking age changed twice in the time period examined (from 18-19 in 1980, and from 19-21 in 1983). The states without Grandfather clauses are: Georgia, Florida, Texas, Ohio, and *Tennessee* (1-year increase); Massachusetts and Illinois (2-year increase); Michigan and Oklahoma (3-year increase).

Multiple groups were examined to increase confidence that observed changes in fatalities were, in fact, due to changes in minimum-drinking-age laws, not other coincidental factors. Changes in fatalities attributable to law changes should be seen only in single-vehicle nighttime crashes involving drivers in age groups affected by the laws, since these are crashes which have a high probability of involving alcohol and include drivers in the age group affected by the new laws. Similar changes were not expected in other groups because none of the laws affected legal access to alcohol of those age 21 and over, and alcohol is significantly less prevalent in daytime than single-vehicle nighttime crashes.[1]

The experimental design was designed to test the following hypotheses:

- fatal single-vehicle nighttime crashes involving drivers among affected age groups will decline subsequent to increases in the minimum drinking age,

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1. Hatfield, N.J, & Hinshaw, W.M. (1987). *An Evaluation of the Effect of Raising the Minimum Legal Drinking Age from 18 to 19.* Texas Transportation Institute.

- fatal single-vehicle nighttime crashes involving drivers over age 21 and fatal daytime crashes will not decline subsequent to increases in minimum drinking age,
- declines in SVN fatal crashes among affected age groups will be greater for laws without grandfather clauses than for those with such clauses, and
- declines in SVN fatal crashes among affected age groups will increase with larger increases in minimum drinking age (i.e., greatest change is expected for laws increasing the drinking age 3 years, followed by 2-year, and then 1-year increases).

Data Collection

Data on motor vehicle crash fatalities were obtained from the National Highway Traffic Safety Administration's Fatal Accident Reporting System (FARS). Data were obtained for each state for three years preceding and three years following each drinking age change. For example, Michigan changed its drinking age law in January, 1979; thus, data for Michigan included fatal crashes from January 1976 through December, 1981. In contrast, Delaware changed its legal drinking age in January, 1984; thus, Delaware data included fatal crashes from January, 1981 through December, 1986.

Data were filtered to include only those crashes in which the state in which a driver was licensed was the state where the crash occurred. Although drivers licensed in states other than the state where the crash occurred are still subject to the laws of the crash state, these drivers were omitted because effects of the laws are best detected using a given state's own population. In addition, data were filtered to provide separate counts based on driver age, and time of day and number of vehicles involved in the crash. Age was divided into two groups: (1) those affected by law changes specific to each states new law, and (2) those age 21 and over. Time of day and number of vehicles involved were also divided into two groups: (1) crashes involving a single vehicle that occurred between 8 p.m. and 4:59 a.m., and (2) all crashes meeting other stated criteria that occurred between 5 a.m. and 7:59 p.m.

Estimated vehicle miles traveled (VMT) and the distribution of licensed drivers by age were obtained from the Federal Highway Administration. Vehicle miles traveled data include all types of vehicles on all classes of roads, and are based on traffic counter and motor fuel sales data provided by states.

Statistical Analyses

Fatality data were plotted to provide preliminary evidence concerning effects of drinking age legislation. These plots also revealed whether long-term baseline trends were present in each series. A moving average trend line was created by summing the six data points preceding and the six data points following each point for which the moving average was calculated and dividing this sum by 12. This procedure is replicated for each of the data points in the series with the exception of the first and last six points of a series. Patterns of raw data points often

have substantial "noise" or variance around a general trend that may mask patterns in the data. Trend lines eliminate much of this "noise," thus making interpretations about general trends and pre-post law change differences more straightforward.

The primary goal of these analyses was to estimate shifts in each fatality time series associated with changes in minimum-drinking-age laws. Box-Jenkins and Box-Tiao (Box and Tiao, 1975; Box and Jenkins, 1976) methods were employed to control for long-term trends and seasonal cycles and to estimate any changes beginning the first month after the laws were changed. The Box-Jenkins approach is a versatile time-series modeling strategy that can model a wide variety of trend, seasonal, and other recurring patterns.

At a conceptual level, the analytic strategy involves explaining as much of the variance in each variable as possible on the basis of its past history, before attributing any of the variance to other variables, such as changes in drinking age laws. The intervention-analysis approach is particularly appropriate for the present study, since the objective was to identify significant shifts in fatalities associated with changes in drinking age laws, independent of observed regularities in the history of each variable. Without these methods, incorrect conclusions can be made. For example, a change in injuries could be fully attributed to a specific intervention, when in fact it is entirely consistent with a pre-existing multi-year cycle in fatalities. In short, controlling for baseline trends and cycles with time-series models produces more accurate estimates of the effects of drinking age legislation.

All time-series were logarithmically transformed to reduce heteroscedasticity before parameters were estimated. All results presented are based on final models that were carefully evaluated to ensure: 1) low correlations among parameter estimates, 2) significant noise model parameters meet requirements for invertibility or stationarity, 3) insignificant residual autocorrelations over the first 36 lags, and 4) parsimonious models accounting for a high proportion of total time-series variance. An intervention variable was added to each model to measure an abrupt, permanent effect of drinking law changes.

Vehicle miles traveled were examined as a potential covariate for these analyses, but final models do not include VMT as a covariate. Vehicle miles traveled was rejected as a covariate for two principal reasons. First, age- and time-specific VMT data are not available. Thus, these general VMT data are not appropriate for controlling exposure since most mileage is traveled by drivers age 21 years and over and during daylight hours. Second, general VMT trends were contrary to those expected (i.e., we expected that as VMT increased, fatalities would also). Thus, VMT proved not to be an effective control for exposure to risk of crash.

We also examined using the number of licensed drivers as a covariate for the analysis. These data (obtained from the U.S. Federal Highway Administration and the Massachusetts Registry of Motor Vehicles) indicated that during the time periods examined in this study, the number of licensed drivers in the affected age groups declined, while the number of licensed drivers age 21 and over increased. We, therefore, controlled for effects these population changes would have on fatality rates by calculating fatality rates per number of licensed drivers for the given age groups. Subsequent time-series analyses were performed on the natural logs of both raw frequency and rate data.

Results are presented in Tables C-1 and C-2. The percent change in *frequency* of alcohol-involved fatal crashes is shown in Table C-1, the percent change in *rate* of alcohol-involved fatal crashes per licensed driver is shown in Table C-2.

Table 1
Effects of Increasing Minimum Drinking Age on Frequency of Alcohol-involved Fatal Crashes

	Percent Change†
Aggregate	
Drivers under age 21 SVN	–13.2
Drivers 21 and over SVN	–04.2
Drivers under age 21 Daytime	–15.2
Drivers 21 and over Daytime	–05.5*
Grandfathered	
Drivers under age 21 SVN	–26.0*
Drivers 21 and over SVN	–06.9*
Drivers under age 21 Daytime	–20.8*
Drivers 21 and over Daytime	–01.2
Nongrandfathered	
Drivers under age 21 SVN	–23.2*
Drivers 21 and over SVN	–02.1
Drivers under age 21 Daytime	–12.4
Drivers 21 and over Daytime	–05.4*
1 year change	
Drivers under age 21 SVN	–24.8*
Drivers 21 and over SVN	03.3
Drivers under age 21 Daytime	01.3
Drivers 21 and over Daytime	–03.3
2 year change	
Drivers under age 21 SVN	–22.9*
Drivers 21 and over SVN	–04.3
Drivers under age 21 Daytime	–30.2*
Drivers 21 and over Daytime	–07.5*
3 year change	
Drivers under age 21 SVN	–27.8*
Drivers 21 and over SVN	–12.8*
Drivers under age 21 Daytime	–32.8*
Drivers 21 and over Daytime	–11.0*

†-Percent change is based on $(e^{\omega}-1)100.$; ω is obtained from Box Jenkins time-series models of natural-log transformed series.

Note: * – $p<.05$

Table 2
Effects of Increasing Minimum Drinking Age on
Rate Per Licensed Driver of Alcohol-involved Fatal Crashes

	Percent Change†
Aggregate	
Drivers under age 21 SVN	–15.4*
Drivers 21 and over SVN	–05.4
Drivers under age 21 Daytime	–13.9
Drivers 21 and over Daytime	–13.3*
Grandfathered	
Drivers under age 21 SVN	–23.9*
Drivers 21 and over SVN	–16.6*
Drivers under age 21 Daytime	–18.6*
Drivers 21 and over Daytime	–11.9*
Nongrandfathered	
Drivers under age 21 SVN	–20.0*
Drivers 21 and over SVN	–03.5
Drivers under age 21 Daytime	–11.6
Drivers 21 and over Daytime	–12.3*
1 year change	
Drivers under age 21 SVN	–21.6*
Drivers 21 and over SVN	00.6
Drivers under age 21 Daytime	02.1
Drivers 21 and over Daytime	–13.0*
2 year change	
Drivers under age 21 SVN	–18.6*
Drivers 21 and over SVN	–09.9*
Drivers under age 21 Daytime	–26.7*
Drivers 21 and over Daytime	–13.9*
3 year change	
Drivers under age 21 SVN	–26.3*
Drivers 21 and over SVN	–17.7*
Drivers under age 21 Daytime	–30.8*
Drivers 21 and over Daytime	–15.5*

†-Percent change is based on $(e^{\omega}-1)100$; ω is obtained from Box-Jenkins time-series models of natural-log transformed series.

Note: * – $p<.05$

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INSTITUTE FOR SOCIAL RESEARCH
THE UNIVERSITY OF MICHIGAN