DEVELOPMENT AND APPLICATIONS OF A CITY-LEVEL ALCOHOL AVAILABILITY AND ALCOHOL PROBLEMS DATABASE

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SUMMARY
Data on alcohol availability and problems in all cities in Los Angeles County were collected from several different sources and linked together to form a Local Alcohol Availability Database (LAAD). The two major purposes of the project are to provide a city-level alcohol availability and alcohol-related problems database needed by local community alcohol policy planners and to collect the data necessary for research on the relationship between these measures. The prevalence of drunk driving arrests is displayed on a map. We describe how the LAAD has been used to guide alcohol policy decisions. A fixed year and city effects regression model suggests that outlet density is positively related to several alcohol-related problems.

INTRODUCTION
During the last 40 years, the individual-level disease model of mental illness has been challenged by alternative models based on external causes. In psychology, these new approaches included community psychology, which focuses on family and social causes of mental illness. Similar changes occurred in the study of alcoholism and alcohol abuse. The disease model of alcoholism, which postulates that alcohol problems are primarily due to the behaviour of the individual, was challenged by two major environmental models. The distribution of consumption model reflects a strict adherence to an environmental model: the amount of available alcohol is directly related to alcohol consumption, which is, in turn, directly related to alcohol problems. Another environmental model, the sociocultural model, identifies the importance of social and cultural influences on alcohol problems.

The disease, distribution of consumption, and sociocultural models have received considerable attention because each model has different implications for alcohol policy. The disease model's focus on the individual and the sociocultural model's focus on social and cultural norms suggest that alcohol availability should not necessarily affect alcohol problems such as alcohol-involved...
traffic crashes, alcoholism, and traumatic injury and violence. In contrast, the distribution of consumption model posits a clear, albeit indirect, relationship between alcohol availability and alcohol problems. For example, the distribution of consumption model predicts that alcohol problems will increase as alcohol availability increases, via an increase in alcohol consumption.

The sociocultural model claims that an increase in availability will lead to an increase in problems only if social and cultural norms change. This simple comparison has been the focus of several studies. The results of these studies show support for both models and considerable controversy remains, ranging from those claiming no evidence for an effect of availability on problems to those endorsing a direct relationship between availability and problems.

Alcohol outlets are generally classified as on-sale and off-sale establishments. Off-sale or off-premises establishments, such as liquor stores, sell alcohol for consumption outside the store. In on-sale or on-premises establishments, such as bars and restaurants, alcohol is consumed at the establishment. Several relationships have been demonstrated in prior studies of alcohol availability and problems, including: major increases in off-sale availability are associated with increases in consumption; availability is associated with consumption at the state level; availability is associated with felony drunk driving at the county level; and on-sale availability is associated with cirrhotic liver deaths at the state level. As an example, Watts and Rabow found a positive relationship between outlet densities and alcohol problems for 213 California cities.

Studies using outlet densities (that is, the number of alcohol outlets per capita) as a measure of alcohol availability have been criticized for several reasons. These reasons include use of cross-sectional rather than longitudinal data; use of aggregate data at the state rather than local level; and measurement of alcohol availability across types of outlet (that is, total number of both on- and off-sale outlets).

**NEED FOR CITY-LEVEL DATA**

Methods used to limit alcohol availability (such as, raising the drinking age, increasing alcohol taxes and prices, restricting hours and days of sale, and decreasing outlet density) have resulted from policy changes at the state level. It has been recognized, however, that cities and local communities are uniquely suited to control the availability of alcohol. Local politicians, police, and administrators deal with alcohol problems on a day-to-day basis, and local zoning and planning ordinances can be used to control alcohol availability. But community planners must have adequate information upon which to base their alcohol control policy decisions. A substantial amount of alcohol-sensitive data has been collected by localities, but few sources aggregate the data for use at the local level and there is not a central database combining the different types of data.

The need for city-level data on alcohol availability and alcohol-related problems arises from research requirements as well as from policy considerations. Prevention researchers now advocate community approaches to the prevention of alcohol problems that may be more feasible for cities than whole states. Community-level indicators of alcohol problems provide the first steps in identifying the overall alcohol-related health status of the community. Geographic displays of health data have a long and important history in medicine. Furthermore, the relationship of alcohol availability to alcohol consumption and problems has not been evaluated across many years and at the city level of aggregation. Community drug prevention would be served by close work between researchers testing hypotheses regarding alcohol availability and alcohol-related problems and community planners seeking to reduce alcohol-related problems.
LOCAL ALCOHOL AVAILABILITY DATABASE PROJECT

In this paper, we describe the development and applications of the Local Alcohol Availability Database (LAAD), an archive of alcohol availability and alcohol-related outcomes for the unincorporated areas and the 84 cities in Los Angeles County. The work was funded by a grant from the National Institute on Alcoholism and Alcohol Abuse. The database from the project now serves as an ongoing resource available to local community planners who wish to examine the prevalence of alcohol-related problems and alcohol availability. Cross-sectional and longitudinal relationships among alcohol availability measures and alcohol-related outcomes are now being assessed, as well as the effect of existing outlet-based legislation on availability and outcomes.

The major goals of the project were: (1) to develop a comprehensive database consisting of alcohol availability and alcohol-related problems for Los Angeles County, (2) to assess the usefulness of this database for community planners and leaders in developing strategies for the control of alcohol-related problems, and (3) to assess the relationship between alcohol availability and alcohol-related outcomes at the city level. A specific research purpose was to assess the impact of alcohol availability (that is, alcohol outlet density) on alcohol-related civil outcomes (such as drunk driving arrests, and drunk in public cases), and alcohol-related health outcomes (such as liver cirrhosis deaths and alcohol-related traffic injuries and fatalities).

IDENTIFICATION OF RELEVANT ALCOHOL AVAILABILITY AND PROBLEMS DATA

Studies of alcohol availability and alcohol-related problems have been conducted with country,24 state,12,25 - 27 county,13,28 - 30 and individual31 - 33 units of analysis. Only one study,15 to our knowledge, has used city-level data. The number of studies has steadily increased since 1976. The total number of outlets was most often studied but there are several studies that examined off- and on-sale outlets. Many outcome measures have been analysed, including traffic casualties, arrests, and health and consumption measures.

DATA COLLECTION

The goal of LAAD data collection was to obtain alcohol availability and alcohol-related problems data for the years 1970 to 1991 for the unincorporated areas and all 84 cities in Los Angeles County, based on the 1991 Alcoholic Beverage Control’s (ABC) report of alcohol licences for Los Angeles County. The first year of data collection was 1970 because we felt that the data from earlier years might be qualitatively different from the most recent data owing to changes in the consistency and type of reporting. Six datasets were identified: (1) ABC – alcohol licences for the years 1970 to 1991; (2) Police – crime reports for the years 1970 to 1990; (3) Census – census population data for the years 1970, 1980, and 1990; (4) Vital statistics – cause of death for the years 1973 to 1987; (5) SWITRS – traffic accident reports for the years 1970 to 1990 from the Department of Motor Vehicles; (6) Legislative – measure of community involvement, defined by the number of requests, denials, and conditional-use permits for alcohol licences, for the year 1990. The data were obtained from published reports or purchased from the data sources.

Alcoholic Beverage Control (ABC) Data

For each city, the annual figures for seven types of alcohol licences were included in the LAAD: type 20 (off-sale beer and wine), type 21 (off-sale general), type 40 (on-sale beer), type 41 (on-sale
beer and wine eating place), type 42 (on-sale beer and wine public premises), Type 47 (on-sale
genereal public eating place), and type 48 (on-sale general public premises). We created indices of
the total number of ABC licences, the total number of the seven licence types above, the total
number of on-sale licences, and the total number of off-sale licences.

**Police Data**

Annual crime reports for each city were obtained from the State Department of Justice. Arrest data for the following offences were included in the data set: homicide, aggravated assault, forcible rape, robbery, burglary, grand theft, arson, total felonies, total misdemeanours, drunk driving, drunk in public, disturbing the peace, and drug law violations. Other composite arrest measures were also included. Part 1 crimes (homicide, aggravated assault, forcible rape, robbery, burglary, grand theft, arson), a composite measure of overall crime used by the Federal Bureau of Investigation (FBI) as a crime index, was included for each year from 1970 to 1990.

**Census Data**

The 1970, 1980, and 1990 censuses provided the following data for each city: population, city size in square miles, median age, median income, number of housing units, number of high school graduates, number of people in poverty, and number of white, black, Asian, and Hispanic people. Data on median income and number of high school graduates were not available for 1970. For the years when census data were not available, we used population values estimated by the California Department of Finance. These estimates are based on birth and death rates plus estimates of immigration and emigration. We created annual percentage variables for the high school graduate, indigent, black, and Hispanic subpopulations by dividing each subpopulation value by total population size and multiplying by 100. Data were also available to estimate annual percentage variables for black and Hispanic subpopulations for the years 1981–89.

**Vital Statistics Data**

Vital statistics data for each city were obtained from the Los Angeles County Health Department, using their database of information keypunched directly from coroner death certificates. We used the County Health Department codebook to determine the number of liver cirrhosis deaths and alcohol-related deaths.

**Statewide Integrated Traffic Reporting System (SWITRS) Data**

The California State Department of Highway Patrol provided traffic casualty data for each city, including alcohol-involved fatal and injury crashes, total fatal and injury crashes, and property damage crashes.

**Legislative Data**

The purpose of the legislative dataset was to determine the level of community involvement regarding the availability of alcohol in each city in 1990. We contacted personnel at each city's planning department by phone and then sent them a planning survey asking questions about the requests, denials, text restrictions, and conditional-use permits (CUP) for alcohol licences in their city.
Some of the index scales on the survey were: (1) strict (denials divided by requests for licences); (2) residential distance to outlets; (3) CUP (strength of CUP process); (4) outlet distance to each other; (5) hours of operation (limited or not); (6) alcohol sold at gasoline location.

Software and Hardware
The six datasets were combined in a single Statistical Analysis System (SAS) dataset. The entire database is on a 386-based personal computer. We use a faster AIX UNIX system to print and run SAS map programs. The database is also stored as part of a network at both Arizona State University and the University of Southern California. The database can be transferred on one high density 3.5 inch floppy disk.

DISTRIBUTION TO LOCAL COMMUNITY PLANNERS
The greatest initial benefit of the database for community planners has been the documentation of the concentration of alcohol outlets for communities with organizations interested in alcohol policy. The public can request reports from the database. Fees are based on data analysis and report preparation costs. Background data have been requested for five different needs as follows.

Background data in application proceedings for new alcohol licences
Community groups opposed to new alcohol outlets in local jurisdictions often request background data on the density of specific outlet types in the area. LAAD data presented in zipcode-level maps documented the density of outlets in a particular area relative to both the ABC density limit and other zipcodes.

Background data for enactment of conditional-use permit ordinances at the city level
A number of cities in Los Angeles County have enacted or attempted to enact CUP ordinances. Community groups in these cities request LAAD data for testimony in public hearings related to the CUP ordinance. Testimony using LAAD data usually documents alcohol outlet density in the city.

Background data for the development of alcohol policy at the state level
In the 1992 assembly, legislation was introduced to address the over-concentration of alcohol outlets in California. The bill was designed to extend alcohol outlet density limits to the city level. LAAD data were used to portray the "over-concentration loophole" for the sponsoring assemblywoman's staff and were included in testimony supporting the bill.

Background data for groups opposing relaxation of existing conditional-use permit ordinances
In 1991, the County of Los Angeles attempted to exempt retail outlets of greater than 15,000 square feet in South Central Los Angeles from the county's CUP ordinance. Community groups organizing against this issue requested that LAAD data be used to describe both the nature of the over-concentration problem in South Central and the cross-sectional relationship between alcohol outlet density and alcohol-related outcomes in Los Angeles County.
Background data for a master plan for alcohol policy in Los Angeles County

LAAD data were requested by the Los Angeles County Department of Alcohol Programs to assist in developing a master plan for the county. Data documenting the density of all alcohol outlet types by city were provided along with longitudinal data documenting the trends in outlet density over the past 20 years at the county level.

MAPS OF ALCOHOL PROBLEMS AND ALCOHOL AVAILABILITY

Visual presentation of the data on maps provides an ideal way to summarize the LAAD data. Locations with an excess of alcohol-related problems can be studied in more detail. Figure 1 shows a chloropleth map of the cities in Los Angeles County based on three levels of the density of drunk driving arrests per 10,000 persons in 1990: level 1 is the first decile, level 2 is the second to ninth decile, and level 3 is the tenth decile. Unincorporated areas are blank. Examination of this map and a map of alcohol outlet density that is not shown suggests that drunk driving arrests are more prevalent in locations where alcohol outlet density is high. This possible relationship is explored in more detail in the statistical analysis described later.

OPPORTUNITIES FOR RESEARCH

One of the benefits of an ongoing alcohol availability and alcohol-related problems database is its use in natural experiments. The civil unrest in 1992 following the trial of the police officers involved in the Rodney King incident led to the destruction of many alcohol outlets in South Central Los Angeles. As shown in Table I, the number of off-sale alcohol outlets per 10,000 persons declined substantially in South Central Los Angeles after the civil unrest. As more LAAD data are collected, we can examine the effects of growth or limited growth in these outlets.

ESTIMATING THE EFFECTS OF ALCOHOL AVAILABILITY ON ALCOHOL-RELATED PROBLEMS

Descriptive statistics for selected LAAD measures in 1990 are shown in Table II. The values for the outcome and availability measures are rates per 10,000 persons. The data are extremely positively skewed. The data more closely approximate a normal distribution, although the tails of most of the individual distributions are extended, after transforming the rates to base 10 logarithms. Five of the outcome measures (drunk driving arrests, part 1 crimes, deaths due to alcohol, liver cirrhosis deaths, total injury crashes) and the availability measure of total off-sale alcohol licences were transformed so that they equal the base 10 logarithms of the rates per 10,000 persons. Some zero rates existed for the remaining six outcome measures (drunk in public arrests, disturbing the peace arrests, total fatal crashes, alcohol-involved injury crashes, alcohol-involved fatal crashes, property damage crashes) and the availability measure of total on-sale alcohol licences. Therefore a small value, called C, was added to each (zero and nonzero) rate before the base 10 logarithm was calculated. That is, these seven measures were transformed so that they equal the base 10 logarithms of the rates per 10,000 persons plus C, where C equals a measure's smallest non-zero value (in the entire dataset) divided by two. Transformed variables were used in the regression analysis described below.
Figure 1. Density of drunk driving arrests in Los Angeles counties, 1990. Unincorporated areas are blank. The first decile is 10–39 arrests per 10,000 persons; 40–1135 arrests per 10,000 persons is the second to ninth decile; more than 1135 arrests per 10,000 persons is the tenth decile.

NOTE
Unincorporated areas are Blank
0 - 39/10,000 = 1st Decile
40 - 1135/10,000 = 2nd thru 9th Decile
> 1135/10,000 = 10th Decile

Statistical Analysis
A fixed effects linear regression model was used to study the relationship between four alcohol problems measures and total on- and off-sale alcohol availability measures for the years 1970 to 1990. The four dependent measures were drunk driving arrests, drunk in public arrests, disturbing the peace arrests, and liver cirrhosis deaths. As described above, each measure represented the
Table 1. Off-sale general outlet density per 10,000 persons in thirteen South Central Los Angeles zipcodes before and after civil unrest.

<table>
<thead>
<tr>
<th>Before</th>
<th>After</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.4</td>
<td>3.8</td>
</tr>
<tr>
<td>3.7</td>
<td>3.5</td>
</tr>
<tr>
<td>8.3</td>
<td>5.4</td>
</tr>
<tr>
<td>3.2</td>
<td>2.6</td>
</tr>
<tr>
<td>4.3</td>
<td>3.1</td>
</tr>
<tr>
<td>4.6</td>
<td>3.1</td>
</tr>
<tr>
<td>5.7</td>
<td>4.4</td>
</tr>
<tr>
<td>6.2</td>
<td>5.0</td>
</tr>
<tr>
<td>5.3</td>
<td>3.6</td>
</tr>
<tr>
<td>5.0</td>
<td>2.5</td>
</tr>
<tr>
<td>2.4</td>
<td>2.1</td>
</tr>
<tr>
<td>5.9</td>
<td>3.6</td>
</tr>
<tr>
<td>3.5</td>
<td>1.6</td>
</tr>
</tbody>
</table>

County-wide density limit for off-sale general outlets is 4.0 outlets per 10,000 persons. There is no density limit by zipcode.

number of cases per 10,000 persons, and then each rate was transformed to its base 10 logarithm. The purpose of this transformation was to reduce the effects of non-normal distributions and of outliers (for example, a small city with a high alcohol outlet density) and to permit interpretation of the results in terms of elasticities. The regression slope $\beta$ provides an estimate of the percentage change in the alcohol problems measure associated with a 1 per cent increase in the availability measure.

The general form of the regression model is

$$\log(Y) = \alpha + \beta \log(A) + \tau X + \epsilon,$$

where $Y$ is a vector of alcohol problems data, $\alpha$ is the intercept, $A$ is a vector of constants for the availability measure, $\tau$ is a vector of regression coefficients for year and city indicator variables, $X$ is a matrix of indicator variables for each year (minus one) and each city (minus one), and $\epsilon$ is a vector of assumed normally distributed residuals. The number of years and cities in each model differed for some of the dependent measures; for example, liver cirrhosis data were available only for the years 1973 to 1987, so 14 indicator variables code the years. Nominal indicator variables were used for years and cities to remove all effects due to these measures. We used these nominal indicators because we are interested in the relationship between availability and alcohol-related problems in this analysis, not yearly trends or city differences.

The parameters of this fixed year and city effects regression model were estimated using ordinary least squares (OLS) and bootstrapping procedures (see Table III). We used bootstrapping sampling procedures to obtain parameter estimates and standard errors because these methods are robust to the violations of some of the assumptions of OLS regression (for example, some of the dependent measures have distributions with extended tails). Similar bootstrapped and OLS parameter estimates and standard errors increase confidence in the accuracy of the estimate of the relationship between availability and alcohol-related problems. Observations
### Table II. Rates per 10,000 persons for selected LAAD measures for cities in Los Angeles County, 1990

<table>
<thead>
<tr>
<th>Outcome measures and population</th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>25th percentile</th>
<th>75th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drunk driving arrests</td>
<td>231.41</td>
<td>945.96</td>
<td>63.77</td>
<td>40.05</td>
<td>101.64</td>
</tr>
<tr>
<td>Drunk in public arrests</td>
<td>94.36</td>
<td>284.51</td>
<td>33.23</td>
<td>9.20</td>
<td>78.24</td>
</tr>
<tr>
<td>Part 1 crimes</td>
<td>344.39</td>
<td>1,585.14</td>
<td>98.87</td>
<td>76.83</td>
<td>130.16</td>
</tr>
<tr>
<td>Disturbing the peace arrests</td>
<td>7.11</td>
<td>27.63</td>
<td>1.94</td>
<td>1.24</td>
<td>4.10</td>
</tr>
<tr>
<td>Deaths due to alcohol</td>
<td>27.10</td>
<td>207.31</td>
<td>1.74</td>
<td>1.38</td>
<td>2.52</td>
</tr>
<tr>
<td>Liver cirrhosis deaths</td>
<td>1.58</td>
<td>1.89</td>
<td>1.35</td>
<td>0.84</td>
<td>1.74</td>
</tr>
<tr>
<td>Total fatal crashes</td>
<td>6.87</td>
<td>37.98</td>
<td>0.94</td>
<td>0.52</td>
<td>1.33</td>
</tr>
<tr>
<td>Total injury crashes</td>
<td>338.07</td>
<td>1,699.62</td>
<td>68.85</td>
<td>54.99</td>
<td>80.83</td>
</tr>
<tr>
<td>Alcohol-involved</td>
<td>47.57</td>
<td>228.25</td>
<td>9.90</td>
<td>7.21</td>
<td>13.09</td>
</tr>
<tr>
<td>injury crashes</td>
<td>3.09</td>
<td>15.82</td>
<td>0.38</td>
<td>0.15</td>
<td>0.73</td>
</tr>
<tr>
<td>Alcohol-involved</td>
<td>106,656.10</td>
<td>392,497.30</td>
<td>41,659.00</td>
<td>20,850.00</td>
<td>77,671.00</td>
</tr>
<tr>
<td>fatal crashes</td>
<td>646.56</td>
<td>3,785.68</td>
<td>102.60</td>
<td>77.85</td>
<td>132.45</td>
</tr>
<tr>
<td>Property damage crashes</td>
<td>106,656.10</td>
<td>392,497.30</td>
<td>41,659.00</td>
<td>20,850.00</td>
<td>77,671.00</td>
</tr>
<tr>
<td>Population</td>
<td>106,656.10</td>
<td>392,497.30</td>
<td>41,659.00</td>
<td>20,850.00</td>
<td>77,671.00</td>
</tr>
</tbody>
</table>

### Availability measures

**Off-sale alcohol licences:**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>25th percentile</th>
<th>75th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Off-sale beer and wine</td>
<td>10.96</td>
<td>39.53</td>
<td>4.19</td>
<td>3.23</td>
<td>5.76</td>
</tr>
<tr>
<td>Off-sale general</td>
<td>9.17</td>
<td>29.43</td>
<td>4.33</td>
<td>3.56</td>
<td>5.25</td>
</tr>
<tr>
<td></td>
<td>20.13</td>
<td>68.91</td>
<td>8.78</td>
<td>6.67</td>
<td>10.63</td>
</tr>
</tbody>
</table>

**On-sale alcohol licences:**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SD</th>
<th>Median</th>
<th>25th percentile</th>
<th>75th percentile</th>
</tr>
</thead>
<tbody>
<tr>
<td>On-sale beer</td>
<td>3.75</td>
<td>22.02</td>
<td>0.59</td>
<td>0.32</td>
<td>1.08</td>
</tr>
<tr>
<td>On-sale beer and wine eating place</td>
<td>13.86</td>
<td>48.70</td>
<td>5.06</td>
<td>3.80</td>
<td>7.17</td>
</tr>
<tr>
<td>On-sale beer and wine public premises</td>
<td>0.74</td>
<td>1.79</td>
<td>0.43</td>
<td>0.12</td>
<td>0.83</td>
</tr>
<tr>
<td>On-sale general public eating place</td>
<td>9.62</td>
<td>41.00</td>
<td>2.62</td>
<td>1.62</td>
<td>4.94</td>
</tr>
<tr>
<td>On-sale general public premises</td>
<td>2.18</td>
<td>7.98</td>
<td>0.86</td>
<td>0.37</td>
<td>1.22</td>
</tr>
<tr>
<td>Total on-sale alcohol licences</td>
<td>30.16</td>
<td>108.97</td>
<td>9.51</td>
<td>7.21</td>
<td>14.88</td>
</tr>
<tr>
<td>Total LAAD alcohol licences</td>
<td>50.29</td>
<td>177.04</td>
<td>18.14</td>
<td>13.93</td>
<td>25.09</td>
</tr>
</tbody>
</table>

Note: Part 1 crimes are an index of homicide, assault, rape, robbery, burglary, theft, and arson. Deaths due to alcohol and liver cirrhosis deaths data are for 1987 as this is the most recent data in the LAAD. The population data are the number of persons in each city, not a rate.

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were sampled with replacement and OLS estimates were obtained in each of 200 bootstrap samples. The mean of the 200 bootstrapped estimates was the bootstrap regression parameter estimate, and the standard deviation of this bootstrapped estimate was the bootstrap standard error.

### Residual analysis

To examine the influence of potential outliers, we estimated model parameters for (1) all cities, (2) cities with at least 10,000 persons (16 cities were excluded) and (3) cities with at least 10,000...
Table III. Availability and alcohol problems regression coefficients

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Sample of all cities</th>
<th>Sample of cities with at least 10,000 persons</th>
<th>Sample of cities with at least 10,000 persons (200 bootstrapped samples)</th>
<th>Sample of cities with at least 10,000 persons (after residual analysis)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>b</td>
<td>s_b</td>
<td>SSE</td>
<td>PRESS</td>
</tr>
<tr>
<td>Off-sale availability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drunk driving arrests</td>
<td>0.0042</td>
<td>0.0897</td>
<td>42.5937</td>
<td>391.2169</td>
</tr>
<tr>
<td>Drunk in public arrests</td>
<td>0.4486*</td>
<td>0.1544</td>
<td>126.1148</td>
<td>1,057.3414</td>
</tr>
<tr>
<td>Disturbing the peace arrests</td>
<td>0.3926*</td>
<td>0.2120</td>
<td>237.9206</td>
<td>383.2490</td>
</tr>
<tr>
<td>Liver cirrhosis deaths</td>
<td>-0.0773</td>
<td>0.0978</td>
<td>38.5295</td>
<td>46.3307</td>
</tr>
<tr>
<td>On-sale availability</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drunk driving arrests</td>
<td>0.5130*</td>
<td>0.0491</td>
<td>39.2994</td>
<td>112.6583</td>
</tr>
<tr>
<td>Drunk in public arrests</td>
<td>0.7196*</td>
<td>0.0859</td>
<td>120.4487</td>
<td>889.2836</td>
</tr>
<tr>
<td>Disturbing the peace arrests</td>
<td>0.6574*</td>
<td>0.1195</td>
<td>233.1355</td>
<td>360.6542</td>
</tr>
<tr>
<td>Liver cirrhosis deaths</td>
<td>0.3481*</td>
<td>0.0838</td>
<td>37.8716</td>
<td>45.4128</td>
</tr>
</tbody>
</table>

Data were available for the years 1970–90 for drunk driving arrests, drunk in public arrests, and disturbing the peace arrests; and 1973–87 for liver cirrhosis deaths.

*p < 0.01;  †p < 0.05;  ‡p < 0.10
persons and no more than 200,000 persons (18 cities and the unincorporated areas were excluded). The results for cities with at least 10,000 persons and no more than 200,000 persons were very similar to the analysis of cities with at least 10,000 persons, so they are not presented. We estimated model parameters after excluding cities with less than 10,000 persons because smaller industrial cities some may be qualitatively different from other cities because of unrealistically high concentrations of alcohol outlets and alcohol problems in the density calculations.

We examined the influence of outliers with the predicted error sum of squares statistic (PRESS). As shown in Table III, the PRESS values suggest that there are outliers in the all cities analysis because the values of the statistic decrease substantially when cities with less than 10,000 persons are omitted from the analysis.

We also examined the following four diagnostic plots:
(1) Studentized residuals by predicted values, (2) residuals by predicted values, (3) residuals by years, and (4) residuals by availability. Several unusual observations were observed with these diagnostics, primarily owing to the replacement of zero values to define the base 10 logarithm and other outlier observations. In a final regression analysis, outlier observations due to zero-valued observations were handled by: (1) using the smallest non-zero rate for each city, rather than for the entire dataset, to calculate the value C used in the base 10 logarithmic transformation; and (2) excluding a city from the analysis when it had a zero rate across all years. Observations were considered to be influential and were excluded from the analysis if they had a value of Cook’s D statistic larger than 4/(n - k - 1), where n is the sample size and k is the number of predictors.

Results

As shown in Table III, the second method to handle zero-valued observations and the removal of influential observations reduced the size of the standard errors and changed the regression coefficients slightly with only two exceptions. The regression coefficient relating off-sale availability and drunk in public arrests was reduced considerably when influential observations were removed. Most of the influential observations were from the city of Los Angeles. The coefficient relating off-sale density and drunk driving arrests is larger when influential observations are removed. The residuals for all regression models were reasonably normally distributed when influential observations were removed, as indicated by a 0.996 or higher correlation between the residuals and their expected values under normality.

There are substantial associations between alcohol availability and alcohol problems measures. Conclusions regarding the statistical significance and magnitude of relationships are generally the same under all of the analysis approaches described above. The substantial relationship between off-sale availability and drunk in public arrests was not present when influential observations were excluded from the analysis. On-sale availability is substantially related to drunk driving arrests, drunk in public arrests, disturbing the peace arrests, and liver cirrhosis deaths. The results suggest, for example, that a 1 per cent increase in on-sale availability is associated with a 0.35–0.51 per cent increase in liver cirrhosis deaths and a 0.51–0.66 per cent increase in drunk driving arrests. The similarity between OLS and bootstrapped estimates and standard errors and the consistency of the estimates after removing influential observations lends further support to the values of the parameter estimates and standard errors.

We did not have extensive information for social and demographic measures. The indicator variables for each city coded the demographic characteristics that were stable over the years. Regression parameters were also estimated for a model including the variables ‘percentage Hispanic’ and ‘percentage Black’ for a subset of cities for the years 1980 to 1990. The conclusions from this analysis were very similar to those reported in Table III with the exception of slightly
larger standard errors. The regression coefficient relating drunk in public arrests and off-sale availability became non-significant, leading to the same conclusion as when influential observations were removed. The inclusion of other social and demographic measures may change the results because of adjustment of the outlet density availability and relationship, and if these variables provide more information than the indicator coding of the cities. We plan to increase the collection of demographic and other sociocultural measures in the future.

Other studies have obtained similar results for the availability and alcohol problems measures. As in our study, Colon\textsuperscript{14} found that on-sale availability is significantly correlated with liver cirrhosis death rates, but off-sale availability is not. In a study of California cities, Watts and Rabow\textsuperscript{15} found that on-sale availability is a significant predictor of public drunkenness arrests and felony drunk driving arrests. In a study of California counties, Rabow and Watts\textsuperscript{13} reported that both on- and off-sale availability are significant predictors of felony drunk driving arrests, but they are not significant predictors of misdemeanour drunk driving arrests or public drunkenness arrests. Our regression results, which are based upon California cities across many years, are consistent with their conclusions. It may be that the place where the alcohol is consumed may differ widely for off-sale outlets, which may attenuate the ability to detect a relationship between the number of off-sale outlets in a city and alcohol problems in a city.

Overall, the results of this analysis and several other studies lend support to the distribution of consumption model which predicts that the availability of alcohol is related to alcohol consumption and alcohol-related problems.

**SUMMARY AND LIMITATIONS**

Combining the needs of local community planners for a database of alcohol availability and alcohol-related problems with research on the role of availability and alcohol-related problems is an ideal form of community alcohol prevention. Most of the measures in the LAAD have high face validity as measures of alcohol-related problems and alcohol availability (for example, alcohol-involved traffic casualties are the problem, not a proxy measure). The city is the unit of analysis because decisions regarding alcohol control policies are most appropriately made at this level.\textsuperscript{10} The LAAD will be a resource for cities to base decisions regarding alcohol legislation. A fixed year and city effects regression model suggests that alcohol outlet density measures are substantially related to several alcohol-related problems.

A limitation of the LAAD is the difficulty of accessing archival data and ensuring the quality of the data that are obtained. Arrest data, for example, are likely to be related to the police enforcement pressure in each city as well as alcohol abuse. The current LAAD does not include consumption or price data by city, but we hope to include these data in the future if funding is available. We also hope to collect sociocultural and demographic data and to standardize the data collection procedures so that data collection will be improved in future years.

There are also several limitations of the fixed effects regression model used to assess the relationship between alcohol availability and alcohol problems. Alcohol problems may be a measure of demand for alcohol, which suggests that the alcohol problems cause the alcohol outlets.\textsuperscript{44} A model with reciprocal causation may be a useful approach in this situation. Demographic and sociocultural measures may be more important predictors of alcohol problems. Even if these social and demographic measures are more powerful predictors, the effects of alcohol availability are important because alcohol outlet density is under the control of local community planners whereas the demographic composition of a city, for example, is not. Other regression approaches including random effects models, non-parametric methods, and lagged models may provide more accurate estimates of the effects of availability on alcohol problems.
Gruenewald et al., however, found that reciprocal causation and random effects do not lead to different conclusions about alcohol outlet density and alcohol problems in their study of availability and consumption with state data. The LAAD will provide ongoing data to test these alternatives.

The LAAD data collection and monitoring system can be established in other cities and counties with corresponding opportunities for research and as an aid to local community planners regarding their alcohol control policy decisions and alcohol prevention programmes. Many of these data already exist in different sources, but development of a LAAD requires data collection and management procedures.

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REFERENCES


