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Heterogeneous Costs of Alcohol and Drug Problems Across Cities and Counties in California

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Abstract

Background—Estimates of economic and social costs related to alcohol and other drug (AOD) use and abuse are usually made at state and national levels. Ecological analyses demonstrate, however, that substantial variations exist in the incidence and prevalence of AOD use and problems including impaired driving, violence, and chronic disease between smaller geopolitical units like counties and cities. This study examines the ranges of these costs across counties and cities in California.

Methods—We used estimates of the incidence and prevalence of AOD use, abuse and related problems to calculate costs in 2010 dollars for all 58 counties and an ecological sample of 50 cities with populations between 50,000 and 500,000 persons in California. The estimates were built from archival and public-use survey data collected at state, county and city-levels over the years from 2009 to 2010.

Results—Costs related to alcohol use and related problems exceeded those related to illegal drugs across all counties and most cities in the study. Substantial heterogeneities in costs were observed between cities within counties.

Conclusions—AOD costs are heterogeneously distributed across counties and cities, reflecting the degree to which different populations are engaged in use and abuse across the state. These findings provide a strong argument for the distribution of treatment and prevention resources proportional to need.

Keywords

violence; child maltreatment; impaired driving; chronic disease; quality of life

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Conflict of Interest

The authors have no conflicts to report.

National assessments of the economic costs of alcohol and other drug (AOD) use, abuse and problems in the US have generally shown that costs related to alcohol use far exceed those related to the use of illegal drugs (Miller and Hendrie, 2009; Miller, et al., 2006; National Drug Intelligence Center, 2011). The essential reasons for this disparity are likely found in the numerous ways legally available drugs become integrated into the social fabric of communities, leading to a dispersion of problems across many social and behavioral domains. Aside from the negative social costs that arise from proscriptions on the use of illegal drugs, such as those related to illegal sales, these restrictions on use limit the environmental contexts in which use might become problematic. In contrast, 80 years of legal alcohol sales, and the progressive liberalization of sales in many states, enables the integration of use into many different social and behavioral domains, extending from purchases in flower shops and pharmacies, through vending machines at sporting arenas and use in other high risk contexts associated with drinking and drunken driving (Gruenewald, 2011). Legal proscriptions on sales of illegal drugs have retarded expansion of use into many contexts, limiting the set of problems related to use (LaScala, et al, 2005).

Neither alcohol nor other drugs are, of course, equally available or used across all populations within states of the US, all communities within states, or all neighborhoods within communities. Although the geographic epidemiology of AOD use, abuse and problems remains in a somewhat nascent phase of development, in every case examined for every drug, patterns of use and related problems are demonstrably heterogeneous across population areas. Consequently, it is reasonable to assume that the social and economic costs of AOD use, abuse and problems will not be equally distributed across populations within geographic areas. It is rather to be expected that these costs will be heterogeneously distributed, reflecting different patterns of use and differences in the social and behavioral domains in which these substances are used. Thus, it is essential to assess heterogeneities in costs related to AOD use, abuse and problems for two important reasons: First, variations in these costs reflect differences in the public health burden carried by different populations and areas of states. Some populations and areas may be more burdened by these costs than others, resulting in an important health disparity to be addressed by public health authorities. An important first step is to assess county-to-county and city-to-city variations in alcohol and drug costs. Second, variations in these costs reflect variations in the mechanisms by which legal and illegal drug markets lead to AOD problems; studies of the distribution of AOD problems and costs across communities provide guidance to future studies of community ecologies of AOD use and problems.

In this paper we address these two concerns using archival and survey data available from the state of California and provide answers to two questions: (1) Are the economic costs related to alcohol use consistently greater than those related to illegal drugs across counties and cities in the state? (2) How substantial are differences in these costs across areas of the state? Answering these questions is a critical step in the assessment of the social ecology of AOD use, abuse and problems. Our approach builds on Rosen, et al. (2008), who assessed the costs of alcohol use and related problems in California. Like Rosen, we do not attempt to estimate economic benefits related to jobs created by commercial alcohol markets or economic costs incurred in repairing additional harms related to alcohol use that lie beyond treatment for abuse, dependence and addiction.

Materials and Methods

Following methods developed and applied by Rosen, et al. (2008) we estimate the costs of harmful drinking and other drug use, defined as any use that creates a harm to the drinker (e.g., liver cirrhosis, overdoses) or to the wider society (e.g., violent crime), both for counties and a subset of cities in the state of California. We examined 4 broad categories of harm for which the causal links with alcohol and other drug use are well defined: illness, injury, crime and traffic collisions. In addition, we estimate the public money spent on the prevention of these problems. The exact methodology for estimating costs differs from one problem to another and is summarized below. Rosen, et al. (2008) provide detailed steps for the development of cost estimates related to alcohol use. We apply these same procedures to problems related to alcohol and other drug use using data available from counties and a selected subsample of cities in the state from 2009 to 2010 (depending on data source, see Table 1).

Data collection was coordinated around the years 2009–2010 to correspond to ongoing archival and survey data collection across counties and for 50 cities in California (see Gruenewald and Remer, 2015). The 50 cities were randomly selected non-adjacent cities in California with populations between 50,000 and 500,000 persons and represent all 138 cities of this size. Data were aggregated to the 58 counties or identified geographic areas within each of the 50 cities. City boundaries were obtained from Geolytics (2010) and overlapping Census block group, tract and ZIP code areas identified. Data reported by city (e.g., crime) were an exact match to city areas. Data reported by tract (e.g., child maltreatment) were a near exact match to city areas. Data reported by ZIP code (e.g., hospital and emergency department discharge data) were an approximate match to city areas. ZIP codes were matched to cities by identified post office name. These areas included 96.7% of city populations while 19.6% of ZIP code populations lived just outside city boundaries.

For each category of harm, we calculated the total number of fatal and non-fatal cases and then isolated the proportion of these cases actually attributable to, or caused by, alcohol or other substance use. To do so, we relied on published alcohol-attributable (AAF) and other drug-attributable fractions which measure the contribution of alcohol or other drugs to health outcomes. For example, an AAF of 0.30 for liver cirrhosis attributes 30% of liver cirrhosis cases to alcohol consumption. We then took cost per case estimates from peer reviewed literature; where this was not possible we calculated original cost per case estimates. The total costs of each alcohol-attributable problem was calculated as:

$$(\text{Total Number of Cases} * \text{AAF} * \text{Cost per Case})$$

We drew AAFs from four studies: a case-control study of impaired driving crashes (Blomberg, et al., 2005), Miller and Hendrie's (2009) synthesis of estimates for crime, Rehm, et al.'s (2006) systematic review of attributable fractions for illness, and Miller and Spicer's (2012) relative risk estimates for injury. When alcohol reduced a health problem, we (negative AAF), we calculated the cases prevented and subtracted rather than added the costs.

Cost Estimation Procedures

All estimated costs are the product of four factors: (1) number of incidents in the jurisdiction (e.g., number of homicides or number of crashes that police reported as alcohol-involved) from data sets listed in Table 1; (2) as applicable, an adjustment for underreporting to the data source used to estimate incidence, based on national underreporting rates from sources listed in Table 1; (3) percentage of incidents probably caused by alcohol or by drugs, generally based on national attribution rates from sources listed in Table 1; and (4) cost per incident, California-specific or based on national studies (listed in Table 1) adjusted to 2010 California prices. To increase estimate comparability between cities, we used the same price for most costs (e.g., a police call) in all jurisdictions. Fatality costs, however, were age and gender-specific. All cost estimates are in 2010 dollars. Supplementary Tables 1–2 list most unit costs, under-reporting, and attribution factors except Rehm et al.'s (2006) standard set used for illness.

We illustrate the estimation procedures by providing detailed calculations of costs for substance abuse and hospital treatment. Substance abuse treatment episodes are annual averages tabulated from de-identified 2006–2011 California Outcomes Measurement System (CalOMS) treatment data. If a patient were treated for both drug and alcohol abuse, we attributed half a case to each substance. We multiplied inpatient and outpatient substance abuse treatment costs from French, et al. (1996) times corresponding inpatient and outpatient ratios of treatment and follow-up costs to treatment costs from Barnett, et al. (2007). We computed average cost per person treated from the estimated treatment and follow-up costs using the CalOMS proportions of inpatient versus outpatient treatment. We converted estimated costs to 2010 dollars using the consumer price index-medical care (Obama, 2013). Finally, we adjusted to California prices using the ACCRA (The Council for Community and Economic Research, 2010) cost of living index for medical care (averaged across California cities).

We used 2009 California hospital inpatient and emergency department discharge censuses to estimate hospital-treated illness and injury incidence. With the exception of alcohol and other drug poisonings (which had an attributable fraction of 1), we assigned attributable fractions for injury from Miller and Spicer (2012) and ignored secondary illness diagnoses. For all other diagnoses, we applied AAFs for alcohol from Alcohol-Related Disease Impact (ARDI) software (Midanik, et al., 2004), for tobacco from Adhikari, et al. (2008), and for drugs from Harwood, et al. (1998). A discharge record includes multiple diagnoses which each could be partially attributable to alcohol, tobacco, or other drugs. The literature has not settled on the best way to compute attributable fractions with multiple diagnoses, especially when some diagnoses are partially attributable to alcohol, some to drugs, and some to tobacco. We computed the attributable fraction for an admission by summing the fractions for all of the patient's diagnoses. If the sum exceeded 1, we gave the primary diagnosis its full alcohol and drug fractions. If the discharge was not yet fully attributable to substance abuse (including tobacco), we scaled down the remaining fractions so that they summed to 1.0 minus the fraction attributed to the primary diagnosis. We gave the primary diagnosis precedence because it is the provider-selected principal driver of treatment need. By multiplying the fractions times the cost of the admission, we arrive at the percentage

fractions of that cost that are attributable to alcohol and to drugs. An alternative, lower-bound approach would be to attribute alcohol based on the diagnosis with the highest attributable fraction for alcohol and similarly for drugs, bounding the total at 100% attributable.

To estimate the costs of hospital admissions, we applied facility-specific inpatient cost-to-charge ratios to charges on the discharge records. These charges exclude professional fees. We estimated those fees using ratios of professional fees to hospital payments from 1994 Civilian Health and Medical Program of the Uniformed Services (CHAMPUS) data and 2000 data from Medstat's MarketScan Commercial Claims and Encounters Database (Lawrence, et al., 2000; Finkelstein, et al., 2006). Non-medical costs for non-admitted emergency department (ED) discharges for injury were determined similarly. California discharge data lacked charge data for these cases. We used average medical costs per case by diagnosis derived by applying cost-to-charge ratios to eight state discharge data sets that included charge data in 2003 (Lawrence, et al., 2009). For illness, we used the mean cost of \$1107 per ED visit from the 2009 Medical Expenditure Panel Survey (MEPS, Agency for Healthcare Research and Quality, 2012). For injuries, we added post-discharge costs and estimates of the value of wage work, household work, and quality of life lost using an existing injury cost model that builds diagnosis-specific work loss estimates from MEPS data plus work outcomes of over 500,000 workplace injuries (Finkelstein, et al., 2006; Lawrence, et al., 2009; Miller, et al., 2012a; Miller, et al., 1995).

Our estimates include monetized estimates of the value of lost quality of life. They are based on diagnosis-specific physician estimates of functional capacity lost and surveys translating functional losses into quality-adjusted life years (QALYs) lost. A QALY is a health status measure calibrated so 1 is perfect health and 0 is death. It measures the portion of the year's quality of life lost to a health event. Monetizing QALYs is long-established (Miller, 1988; French, et al., 1996; Tolley, et al., 1994; Zarkin, et al., 1993), and widely practiced by leading economists (Becker, et al., 2005; Cutler and Richardson, 1998; Murphy and Topel, 2006; Nordhaus, 2003), but not universally accepted conceptually or empirically (Kenkel, 2001; Hammitt, 2007; Johnson, 2005). For comparison, and as needed, we provided estimates with and without QALYs included.

To extract the number of QALYs lost, we divided the quality of life estimates shown by \$211,157. The costs we adopted valued QALYs using a systematic review of more than 60 "willingness to pay" studies (Miller 1990) that underpinned a generation of regulatory impact analyses (Duvall & Gribbin 2008). These studies analyzed what people actually paid for small changes in their risk of dying or what they reported in surveys that they were willing to pay. They yielded values of a statistical life, the amount a group of people collectively will pay in the expectation of saving one life. That value includes a lost lifetime of wage/household work and QALYs (Miller, 2000). Subtracting the value of lost work and dividing by the present value lifespan implicit in the value yielded the \$211,157 value.

The death and injury costs in these estimates are incidence-based. This means that if a permanently disabling injury in an impaired driving crash or assault occurred in 2010, we count the lifetime of medical costs and work losses that result (incidence-based costs). (We

converted costs in future years to present value using the 3% discount rate recommended by the Panel on Cost-Effectiveness in Health and Medicine (Gold, et al., 1996.)) We exclude costs of treating impaired people injured before 2010 even if they had medical expenses in 2010. For chronic illnesses linked to drug and alcohol abuse like cancer, cirrhosis, and heart disease, data limitations forced us instead to count all medical care costs in 2010, regardless of when the illness occurred (prevalence-based costs). Hodgson (1988) shows that absent technological change, if disease incidence has been stable, prevalence-based costs will equal incidence-based costs. With rising incidence, our procedure underestimates the medical costs of chronic illness. We also were unable to estimate wage, household work, and quality of life losses for those illnesses, so the estimates omit those associated costs.

We often discuss costs in two collapsed categories. Tangible costs include spending on medical care, property damage, public services (police, fire, etc.), adjudication, and sanctioning. Tangible costs can be direct (paid out of pocket) or indirect (e.g., the value of wages and fringe benefits not earned or the estimated cost of replacing household work not done, because people are killed, injured, or ill). Intangible costs put a value on things one cannot buy and sell -- pain, suffering, and lost quality of life.

Finally, to compute the portion of costs that government pays, we assumed that the share of medical costs of substance abuse paid by MediCal, Medicare, and other government programs would mirror government's share of all medical care payments in California. Government will pay all the public services, adjudication, and sanctioning costs associated with violent crime and property crime. We assumed that taxes on lost sales and income taxes on lost wages would be at state average percentages of per capita income.

Results

Substance misuse and abuse costs in California are conservatively estimated at \$52.6 billion (counting tangible costs only), but increase to \$172.6 billion when quality of life losses are included. Alcohol misuse and abuse cost 2.9 times as much as drug abuse. Based on full lifetime costs, alcohol misuse and abuse cost an estimated \$128.7 billion and illicit drug abuse \$43.9 billion (Table 2). Public services costs are higher for drug abuse, however, because it causes a larger share of non-violent crime than alcohol. Overall, substance misuse and abuse in California cost an estimated \$4,625 per capita in 2010 with alcohol misuse and abuse costing \$3,449 and illicit drug abuse \$1,176.

Costs by Cost Category

Table 2 summarizes these costs by cost category and substance. It includes seven categories of costs. Tangible costs include (1) medical costs including lifetime medical costs due to injury and acute inpatient care costs for alcohol-related illness; (2) property damage and loss due to impaired driving crashes and crime; (3) costs of public services including police, fire department, victim, and child protective services as well as adjudication and sanctioning costs; (4) work loss including loss of wages and fringe benefits due to injury, death, and perpetrator incarceration; (5) household work losses due to injury and death; and (6) miscellaneous impaired driving crash costs including insurance claims processing, travel delay, and employer costs of workplace disruption and rehiring. Intangible costs are (7)

quality of life losses to death and nonfatal injury. These losses are valued based on the monetized quality-adjusted life year (QALY) approach (described below). As Table 2 shows, quality of life loss dominated the total estimated costs (69.6%). Medical costs (7.1%) and lost wage work (13.1%) also were large cost categories.

Costs to Government

As shown in Table 3, exclusive of quality of life, government sources paid an estimated 24% of the costs of substance abuse in California in 2010. The estimated government bill totaled \$12.5 billion. California state and local government shouldered a large share of the bill. Their estimated costs totaled \$7.0 billion or \$188 per resident. California state government paid \$1.4 billion in MediCal costs and absorbed \$961 million in tax losses. State and local government shared the \$4.7 billion in police, fire department, adjudication, sanctioning and child protective services costs. Federal costs, virtually all for health care, were \$5.5 billion. We did not estimate the private insurance bill.

Costs by Type of Harm

Table 4 summarizes estimated costs by type of harm and percent costs related to quality-adjusted life years. In this table, Impaired Driving includes both fatal and nonfatal (injury or property-damage-only) crashes. Violence is also reported by fatal and non-fatal, and includes homicide, assault, rape and other sexual assault, and robbery. Non-violent Crime includes property crimes like burglary and vandalism as well as public disorder crimes like loitering, vagrancy, prostitution, gambling, driving under the influence (non-crash), and public drunkenness. We excluded other traffic violations. Other Mortality includes substance abuse deaths from suicide, drug overdoses, unintentional non-crash injury, and acute and chronic illness. The fatality estimate for alcohol-linked illnesses takes into account the potential health benefits of moderate drinking. Other Nonfatal Injury captures all injury, except injury resulting from assaults and road crashes, that is attributable to substance abuse and where survivors are treated in hospital inpatient or emergency departments. It includes falls, poisonings, burns, near-drownings, etc. Medical Cost of Illness includes discharges from hospital inpatient or emergency departments for illness attributable to substance abuse. FASD/Risky Youth Sex captures costs of all Fetal Alcohol Syndrome (FASD) and of sexually transmitted diseases resulting from unprotected alcohol-involved youth sex, under the assumption that half of these youth sexual incidents are attributable to alcohol.

Impaired driving in California cost an estimated \$26.4 billion in 2010, with crashes attributable to alcohol dominating these costs. Of the estimated \$10.1 billion in violence costs linked to substance abuse, 73% were separately attributed to alcohol and 27% to illicit drugs. Conversely, 82% of the estimated \$4.2 billion in non-violent crime costs were attributable to drugs as were 74% of the estimated \$2.0 billion in treatment costs.

Incidence and Costs by Mortality

In 2010, alcohol caused or contributed to an estimated 22,281 deaths in California and drug abuse added another 5,533. Deaths (summed across the Impaired Driving, Violence, and Other Mortality categories) accounted for 64% of the estimated \$172.6 billion in substance abuse costs in the state. Injury deaths alone – including impaired driving crashes, homicides,

suicides, and overdoses among others – accounted for 28%. Long-term illness deaths associated with substance abuse accounted for the remaining 36%.

In 2009, substance misuse and abuse in California caused or contributed to an estimated 514,000 violent crimes – rapes, robberies and assaults – with alcohol responsible for 350,000 and illicit drugs for 164,000. An estimated 47,400 crashes in California involved drugs or alcohol, with 44,500 involving alcohol only, 2,600 involving drugs only, and 300 involving both. However, police reported only a fraction of these crashes as impaired driving. Most nonfatal costs of substance abuse in the state resulted from violence, impaired driving crashes, and other injuries. Despite the greater harm from alcohol, 73% of the 193,000 Californians in substance abuse treatment were being treated for drug abuse.

Geographic Heterogeneity

Table 5 provides characterizations of the geographic heterogeneity of costs across counties and cities by type of harm and class of substance. The lines of the table provide the range (minimum, maximum), range ratio (maximum/minimum), median, mean, standard error of the mean, and coefficient of variation of costs related to the use of alcohol and illicit drugs across 58 counties (top) and 50 cities (bottom). Supplemental tables 3–4 provide additional details on these costs by county and by city. Here it is important to note that in all cases coefficients of variation were much less than 1.00, indicating reasonably precise estimates of city means; there were substantive differences between counties and cities in the ratio of alcohol to drug, and alcohol, drug and total substance abuse costs. The ratio of alcohol to drug costs was significantly greater than 1.00 across counties ($z=23.38$, $p<0.001$) and cities ($z=22.99$, $p<0.001$). Ranges of variation were quite large with minimum and maximum substance abuse costs differing by factors up to 3.42 and 12.01 for counties and cities respectively.

Figure 1 shows county-level estimates of substance abuse costs per capita for alcohol (1a) and illicit drugs (1b), and the percent of all substance-abuse costs related to alcohol (1c). In general, per capita burden was concentrated in the more rural northern and central areas of the state excluding the San Francisco Bay Area. The spatial distribution of costs was generally similar for alcohol and drugs. But, as Figure 1c shows, the proportional burden related to alcohol was uniformly greater than that for other drugs, and alcohol burden was greatest in the north central valley, more rural southern counties and Los Angeles. Costs related to illicit drug use were most substantial in the state's northern tier and San Francisco Bay area. We did not test the statistical significance of the differences observed because we were unable to compute standard errors for the local cost estimates.

Against this background of regional heterogeneity, different cities in California exhibited much different costs. Figure 2 compares costs by counties in three regional areas with costs estimated for selected cities in those areas. As shown on the left of Figure 2, costs related to substance abuse varied considerably between cities within counties, with some city areas exhibiting far greater costs than others (darker areas). For example, the city of Richmond on the eastern side of San Francisco Bay (circled in uppermost left map) exhibited far greater costs than all other cities in the Bay area. As shown on the right, although costs related to alcohol use continued to dominate the picture, urban areas tended to have greater costs

related to illicit drug use (lighter areas). The city of Richmond (circled in uppermost right map) also exhibited proportionately greater illicit drug costs than other cities.

Discussion

Assessments of economic costs related to substance use weight the diverse health and social consequences of AOD and are useful for communicating the magnitude of substance abuse problems, patterns and risks across diverse areas of the nation. These assessments also help set priorities for allocation of scarce prevention and treatment resources, compare performance of prevention and treatment efforts and help to quantify returns on prevention and treatment investments (Miller, et al., 2012a). A major strength of the current analysis is the rich incidence data underlying it. Substance abuse costs proved hard, but not impossible to estimate well at county and city levels. Local costs like those in the online supplement can be helpful tools in drawing attention to local community-based prevention efforts (Flewelling, et al., 2013).

Our estimates of costs related to illicit drug use appear to be the first calculated for California. Our \$37.5 billion estimate of the tangible costs of alcohol abuse in California in 2010 matches the estimate of \$35.0 billion by Sacks, et al. (2015). Sacks, et al., however, estimated that government paid \$14.5 billion rather than \$6.8 billion of the costs. This difference largely results because we only treat lost personal income, property and sales taxes as losses to government, while Sacks et al. also assume corporate revenues decline if someone loses income due to illness or injury. We think the latter assumption is questionable both because the economy is not at full employment and because medical provider profits and associated taxes, for example, instead may increase. Including quality of life loss, our \$129 billion estimate of alcohol abuse costs in California is well above a \$98 billion figure in 2005 (inflated to 2010 dollars) by Rosen, et al. (2008). The major difference is our use of more recent, more comprehensive estimates of the fractions of various illnesses and injuries that are attributable to alcohol. For illness deaths, we also scanned for diagnoses like cirrhosis and specific cancers among all listed causes of death rather than rely exclusively on the first-listed cause. The result was a rise in estimated alcohol-attributable illness deaths from 5,382 to 17,316. Scanning all diagnoses is more appropriate because secondary causes are defined as significant conditions contributing to the death. Moreover, underlying cause of death too often is not registered well (e.g., death processes like choking on own vomitus or respiratory arrest, depression rather than self-inflicted gunshot wound). Our drunk driving costs also are higher. Rosen, et al. (2008) adopted modeled estimates. We instead scanned police reports to determine alcohol involvement, then applied a new Federal algorithm for estimating under-reporting of crash alcohol involvement (Miller, et al., 2012b). Conversely, our estimated violence costs are lower than Rosen, et al.'s because police-reported violence in California has declined since 2005.

A recurrent issue in costing social problems is whether to include impacts on quality of life and how to value them. Ignoring these intangible outcomes when allocating resources or evaluating programs would inappropriately skew the results (Gold, et al., 1996). That does not mean the costs need to be monetized. We consistently have separated out our quality of

life estimates. They can be omitted from the costs and expressed instead in a widely used non-monetary measure, quality-adjusted life years (QALYs, Gold, et al., 1996).

Our analysis bears the limitations of the unit cost studies it relies on, notably reliance on old data for some cost factors. It omits environmental costs of methamphetamine production, work loss and quality of life costs of illnesses linked to substance abuse, and substance abuse treatment at facilities that do not accept MediCal or Medicare. It relies on national average under-reporting rates and attributable fractions for drugs and alcohol. That means differences observed between jurisdictions could in part result from differential police reporting rather than differential harm levels. If data on alcohol consumption or outlet density by community were available, we would have tailored attributable fractions spatially. A further limitation is our inability to cost impacts of substance abuse on social cohesion, personal security and perceived community safety and walkability. These limitations mean the costs are slightly under-estimated, but only the lack of local consumption data poses a threat that the spatial pattern of costs presented here is skewed.

The Price of Prevention: Heterogeneous Costs and Prospective Benefits

The current study is one of a series examining social ecological mechanisms and outcomes of AOD use across 50 cities in California. The core objectives of these studies are two: first, they assess the distribution of alcohol and drug related problems across geographic and social space enabling the identification of those human communities which most suffer from these problems. Studies of the distributions of incidence and prevalence of AOD problems over space and time (e.g., intimate partner violence, Cunradi, et al., 2012; child abuse and neglect, Freisthler, et al., 2007; motor vehicle crashes, Ponicki, et al., 2013; violent assaults, Mair, et al., 2013; methamphetamine abuse, Gruenewald, et al., 2012; prescription opioid abuse, Cerda, et al., 2016) demonstrate the need for rational allocation of scarce prevention and treatment resources. Second, they focus research efforts on elucidating the micro-ecological human social mechanisms that accelerate risks for AOD problems. Studies of the context specific social mechanisms by which alcohol and other drug use accelerate risks (e.g., youth access and problems, Lipperman-Kreda, et al., 2015; sexual risk taking, Mair, et al., 2015; child abuse and neglect, Freisthler and Gruenewald, 2013; drinking and drunken driving, Gruenewald and LaScala, 2016; marijuana use, Freisthler, et al., 2015) demonstrate that novel preventive interventions can be developed to ameliorate problem risks. Most importantly, however, all this work finds dramatic heterogeneity in problem incidence between cities, neighborhoods within cities, and social strata in these neighborhoods. The current findings begin to confirm these conclusions by showing both county and city level variations in costs that reflect prevention needs and should help define appropriate prevention responses. Figure 2 confirms that analyses of substance abuse patterns requires a fairly fine-grained focus at the city rather than the county, or indeed the state, level.

Efficient funding of substance abuse prevention, enforcement and treatment hinges upon understanding the geographic heterogeneity in costs by cities within counties. For example, our data can inform local decisions about prioritizing police enforcement of impaired driving versus drug-related crime. Resource allocation rules need to recognize that cities are heterogeneous with respect to counties and counties with respect to the state. Because

estimated costs combine data across many outcome metrics, they provide an effective, comprehensible, and comprehensive measure for use in modeling how structural differences between communities shape their distinctive social ecologies and for evaluating the outcomes of interventions.

Recognizing the Costs of Cost Estimates

Methods for estimating health care costs related to alcohol and other drug use are inherently problematic. The identification of proper counterfactuals (see Horverad, 2010), data quality, the inclusion of potential benefits related to use and the subjective nature of some quality of life calculations have all been a matter of debate. The last three concerns are particularly important to address when using data from county and community areas. Data quality may be a major concern since alcohol and drug outcomes may be reported differently in different places (e.g., crime codes, Uhl, et al, 2014). This concern is minimized in the current study through the use of common data reporting systems across counties and communities in California. Neglect of potential benefits related to use, particularly economic benefits related to commercial alcohol sales, may also be a concern in communities in which tourism predominates (Crampton and Burgess, 2012). While it is inevitable that there will be some variations between communities in this respect, with some counties including large tourist areas (e.g., Lake Tahoe) and others not, the cities selected for analysis here were not those characteristically identified as tourist destinations. Finally, since QALYs are calculated in the same way among different people and people in different stages of their lives, variations in population demographics from one community to another will affect these estimates. And, since QALYs include intangible costs related to suffering and pain (Single, 2003; Jarl, et al., 2002) some suggest also considering intangible benefits related to use (Crampton and Burgess., 2012). However, these arguments lead far beyond the primary concerns of health care cost estimation, that is the estimation of costs independent of benefits related to either the economic performance of alcohol markets or personal alcohol use.

Research on the causes and correlates of the geographic cost variations could further inform policy decisions. Possible drivers include population and alcohol outlet densities, demographic and socio-economic profiles, and features of the policy and enforcement environments.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1.
Patterns of Substance Abuse Costs by California County

Figure 2.
Patterns of Substance Abuse Costs in Cities within Counties in 3 California Regions

Table 1

Sources Used to Estimate Incidence and Costs of Harm Attributable to Substance Abuse

Event	# Cases	Underreporting	Attribution	Unit Costs
Impaired Driving Deaths	2010 Fatality Analysis Reporting System (FARS)	FARS infers missing driver alcohol involvement	Zaloshnja et al. 2013	Zaloshnja et al. 2013
Impaired Driving Crashes	2010 CA Highway Patrol Statewide Integrated Traffic Records System	Miller et al. 2012; Blincoe et al. 2002	Zaloshnja et al. 2013	Zaloshnja et al. 2013
Index Crimes	2009 Uniform Crime Reports	National Crime Victimization Survey online analysis; Miller et al. 1996	Miller & Spicer 2012, Miller et al. 2006	McCollister et al. (2010), Miller 2012
Arrests	2009 CA Monthly Arrest and Citation Register (MACR)	Bureau of Justice Statistics 2011, Tables 4.6 and 4.72	Miller & Spicer 2012; original estimates	Miller 2012
Child Maltreatment	2008 Child Welfare Service data system	Sedlak et al. 2010	Miller et al. 2006	Fang et al. 2012, Miller 2012
Acute & Chronic Disease Mortality	2010 CA Vital Statistics Multiple Cause of Death data	N/A	Rehm et al. 2006, 2009	Finkelstein et al. 2006
Other Injury Mortality	2010 CA Vital Statistics Multiple Cause of Death census	N/A	Rehm et al. 2006, 2009	Finkelstein et al. 2006
Diseases Treated in Hospital Inpatient or Emergency Department	2009 CA Hospital & ED Discharge Data censuses	N/A	Harwood et al. 1998; Midanik et al. 2004	Charges on file * Cost-to-charge ratios * 1994 CHAMPUS professional fee to inpatient cost ratio
Injuries Treated in Hospital Inpatient or Emergency Department	2009 CA Hospital & ED Discharge Data censuses	N/A	Miller & Spicer 2012	Finkelstein et al. 2006; Lawrence et al. 2009
Substance Abuse Treatment	2006–2011 California Outcomes Measurement System Treatment data	N/A	N/A	French et al. 2008 + follow-up care from Barnett et al. 2008
Risky Youth Sex	2011 Youth Risk Behavior Survey	N/A	assumption	Miller 2004

Table 2

Costs of Substance Abuse by Class of Substance and Cost Category, California, 2010

Cost Category	Alcohol	Illicit Drugs	Total	% of Total
Medical	\$8,331,000,000	\$4,006,000,000	\$12,337,000,000	7.1%
Wage Work	\$17,335,000,000	\$5,321,000,000	\$22,657,000,000	13.1%
Household Work	\$6,819,000,000	\$1,848,000,000	\$8,667,000,000	5.0%
Public Services	\$1,328,000,000	\$3,352,000,000	\$4,680,000,000	2.7%
Property Damage	\$1,791,000,000	\$425,000,000	\$2,216,000,000	1.3%
Miscellaneous Motor Vehicle	\$1,925,000,000	\$122,000,000	\$2,046,000,000	1.2%
Subtotal: Tangible Costs	\$37,529,000,000	\$15,074,000,000	\$52,603,000,000	30.5%
Quality of Life	\$91,195,000,000	\$28,821,000,000	\$120,016,000,000	69.6%
Total	\$128,724,000,000	\$43,895,000,000	\$172,619,000,000	100.0%

Table 3

Government's Substance Abuse Bill by Cost Category and Level of Government, California, 2010

	State/Local	Federal	Total
Alcohol			
MediCal	\$916,000,000	\$2,333,000,000	\$3,249,000,000
Tax Loss	\$735,000,000	\$1,540,000,000	\$2,275,000,000
Public Services	\$1,328,000,000	\$0	\$1,328,000,000
Total	\$2,980,000,000	\$3,873,000,000	\$6,852,000,000
Drugs			
MediCal	\$441,000,000	\$1,122,000,000	\$1,562,000,000
Tax Loss	\$226,000,000	\$473,000,000	\$698,000,000
Public Services	\$3,352,000,000	\$0	\$3,352,000,000
Total	\$4,018,000,000	\$1,595,000,000	\$5,613,000,000
Sum: Alcohol + Drug			
MediCal	\$1,357,000,000	\$3,454,000,000	\$4,811,000,000
Tax Loss	\$961,000,000	\$2,013,000,000	\$2,974,000,000
Public Services	\$4,680,000,000	\$0	\$4,680,000,000
Total	\$6,998,000,000	\$5,467,000,000	\$12,465,000,000

Table 4
Costs of Substance Abuse by Class of Substance and Type of Harm, the State of California, 2010

Harm	Alcohol Cost	% Quality of Life	Illicit Drug Cost	% Quality of Life	Total Cost	% Alcohol*
Impaired Driving	\$24,798,000,000	40.9%	\$1,575,000,000	41.5%	\$26,373,000,000	94%
- Fatal	\$4,766,000,000	70.1%	\$323,000,000	65.4%	\$5,089,000,000	94%
- Nonfatal	\$20,033,000,000	0.6%	\$1,252,000,000	0.0%	\$21,284,000,000	94%
Violent Crime	\$7,354,000,000	67.6%	\$2,709,000,000	66.8%	\$10,063,000,000	73%
- Fatal	\$5,860,000,000	83.3%	\$1,498,000,000	80.0%	\$7,358,000,000	80%
- Nonfatal	\$1,494,000,000	82.0%	\$1,211,000,000	83.3%	\$2,705,000,000	17%
Non-violent Crime	\$729,000,000	0.0%	\$3,423,000,000	0.0%	\$4,152,000,000	18%
Child Maltreatment	\$1,162,000,000	0.0%	\$841,000,000	0.0%	\$2,003,000,000	58%
Other Mortality	\$69,006,000,000	63.5%	\$27,574,000,000		\$96,580,000,000	71%
Other Nonfatal Injury	\$20,910,000,000	70.8%	\$4,541,000,000	65.7%	\$25,450,000,000	82%
Medical Cost of Illness	\$3,471,000,000	40.9%	\$1,767,000,000	41.5%	\$5,237,000,000	66%
Substance Abuse Treatment	\$528,000,000	70.1%	\$1,466,000,000	65.4%	\$1,994,000,000	26%
FASD/Risky Youth Sex	\$766,000,000	0.6%	Not Estimated	0.0%	\$766,000,000	100%
Total	\$128,724,000,000	67.6%	\$43,895,000,000	66.8%	\$172,619,000,000	75%

* Computed by row as Alcohol Cost divided by Total Cost

Table 5

Heterogeneity of Substance Abuse Costs Across 58 Counties (top) and 50 Cities (bottom) in the State of California, 2010

County:	Alcohol Abuse Costs per Capita:	Drug Abuse Costs per Capita:	Substance Abuse Costs per Capita:	Ratio of Alcohol to Drug Abuse Costs:
N	58	58	58	58
Minimum	\$2,588	\$608	\$3,385	1.33
Maximum	\$7819	\$3,786	\$11,605	6.44
Range Ratio	3.02	6.23	3.42	4.82
Median	\$4,018	\$1,365	\$5,516	2.96
Mean	\$4,366	\$1,604	\$5,970	2.97
Standard Error	\$159	\$95	\$232	0.12
Coefficient of Variation	0.28	0.45	0.29	0.29
City:				
N	50	50	50	50
Minimum	\$897	\$379	\$1,276	0.57
Maximum	\$10,734	\$7,159	\$15,324	4.07
Range Ratio	11.96	18.89	12.01	7.14
Median	\$3,050	\$1,261	\$4,192	2.41
Mean	\$3,389	\$1,569	\$4,958	2.46
Standard Error	\$251	\$164	\$381	0.11
Coefficient of Variation	0.52	0.73	0.54	0.30