The Societal Cost of Excessive Drinking in North Carolina, 2017

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BACKGROUND Excessive drinking, including binge and heavy drinking, is a leading cause of morbidity and mortality in North Carolina. In 2010, excessive drinking cost North Carolina $7.03 billion, and this analysis aimed to update this figure for 2017.

METHODOLOGY Following the methods of Sacks, et al. (2015), we obtained proxies for the 2010 and 2017 incidence and price for 26 alcohol-attributable cost components. We then multiplied each component’s 2010 cost by the incidence trend (2017 incidence/2010 incidence) and price trend (2017 price/2010 price) to estimate the 2017 cost. Finally, we summed these cost components to calculate the total cost and allocated them by payer and county.

RESULTS Excessive drinking cost $9.72 billion in North Carolina in 2017, which equals approximately $2.09 per standard drink. Government paid $4.43 billion (45.6%), drinkers paid $3.76 billion (38.7%), and persons other than the drinker paid $1.53 billion (15.7%).

LIMITATIONS These methods relied on alcohol-attributable fractions, which were calculated using scientific literature and national data. If consumption patterns differ between the United States and North Carolina, these fractions may not generalize. Scaling processes may over- or underestimate individual cost components, so total state costs should be interpreted as estimates.

CONCLUSIONS The societal costs from excessive drinking are high but spread across public sectors. This can make it difficult to attribute this burden to alcohol. While drinkers paid less than half of the costs of excessive drinking, a broad range of stakeholders bore the burden. Evidence-based strategies to reduce excessive drinking may decrease these costs.

Alcohol is the most commonly used drug in North Carolina. In 2017, just over half of the state’s adult population (50.4%) drank alcohol in the past month compared to under 1 in 5 (17.5%) who smoked tobacco [1]. Roughly one-quarter (26.5%) of those drinkers binge drank (i.e., drank ≥ 5 alcoholic drinks for men and ≥ 4 alcoholic drinks for women on one occasion) [1]. The harms associated with alcohol consumption are varied, including falls, violence, cancer, gastritis, motor vehicle crashes, and even death [2]. In 2017, there were 33,072 visits to North Carolina emergency departments for acute alcohol intoxication, and 1742 persons experienced incarceration at some point during the year whose most serious crime was driving while intoxicated or being drunk and disorderly in public [3]. That same year, approximately 3991 North Carolinians died from causes attributable to alcohol [4].

There have been ongoing debates about whether North Carolina’s state monopoly on retail spirits limits alcohol access too much [5]. In 2016, per capita liquor consumption in North Carolina (2.27 liters of pure alcohol per person aged 15+) was almost identical to that of Alabama (2.29) and Virginia (2.31) but lower than that of the other states in the region (2.53 in Georgia to 3.61 in Louisiana) [6]. However, drinkers rarely consume only one type of alcohol, and North Carolina had the second-highest per capita wine consumption (1.60) in the region that year [6]. Drinking patterns directly determine the harms that manifest [7], and it is important to consider both how people drink as well as the local burdens to inform effective alcohol regulations.

Diverse stakeholders are interested in alcohol policy decisions, including (but not limited to) the government, business, the public, and public health. When these stakeholders’ interests are at odds, policy decisions can reach an impasse. Finances often inform policy decisions; budgets can constrain which policies are implemented, and cost analyses can put a price tag on the consequences for each potential stakeholder. Still, the societal costs are often missing from economic discussions [8]. Cost-of-illness (COI) analyses can support evidence-based policy decisions by: 1) making it possible to compare heterogeneous problems by reducing their burdens to a common scale: money, 2) identifying health sectors that bear the largest burden, and 3) making problems that are hard to “see” more plain [8-10].

A previous analysis estimated that excessive drinking (i.e., binge drinking, heavy drinking, and any alcohol consumption by underage youth or pregnant women) cost North Carolina $7.03 billion in 2010 [11]. The present study aimed to use state-specific data to update these estimates for 2017 using previously established methods [11-13]. We then disaggregated the total costs by payer (i.e., drinkers, others, and the government), county, and standard drink. To provide context, we also report detailed data on drinking patterns in North Carolina in 2017.
Methods

Overview

This study applied methods developed by Sacks, et al. (2015) to North Carolina in 2017. This approach is based on the Guidelines for Cost of Illness Studies in the Public Health Services [14]. COI studies aim to total the resources consumed or lost because of a particular disease or behavior [15]. We combined a societal perspective [16], which includes drinkers, persons other than the drinker, and the government, with a 1-year time horizon (calendar year 2017) to illuminate the impact of excessive drinking not only on the drinker but on society as a whole.

Drinking Patterns

We used data from the 2016–2018 Behavioral Risk Factor Surveillance System (BRFSS) to calculate a 3-year average of 2017 drinking patterns [17–19]. Coordinated by the Centers for Disease Control and Prevention (CDC), BRFSS uses a dual-frame landline- and cell-phone-based sampling design. The sample sizes for North Carolina were 6300 in 2016, 4931 in 2017, and 4491 in 2018. Because these sample sizes were unequal, we apportioned the sampling weights by survey year following the BRFSS methods for complex survey weighting and conducted all analyses in Stata v.16.1 using “svy” commands to account for complex weighting [20]. We used data from 3 of the BRFSS alcohol questions (all use a past-30-day recall period to define “current” drinking): 1) frequency (i.e., number of drinking days), 2) quantity (i.e., average number of drinks on drinking days), and 3) binge occasion frequency (i.e., the number of binge drinking occasions). BRFSS defines binge drinking as ≥ 5 drinks on an occasion for males and ≥ 4 drinks on an occasion for females, and heavy drinking as males averaging ≥ 15 drinks per week and females averaging ≥ 8 drinks per week.

We calculated a 3-year average of the 2017 prevalence of current, binge, and heavy drinking. To identify current (i.e., past 30-day) drinkers, we dichotomized drinking frequency as ≥ 1 drinks (current drinkers) versus 0 drinks (current abstainers). We used the BRFSS-derived binge and heavy drinking variables to identify binge and heavy drinkers, respectively. We then defined excessive drinking as binge and/or heavy drinking. Finally, we created a mutually exclusive variable. The 3 categories were: abstainer (i.e., did not drink any alcohol); current, non-excessive drinker (i.e., drank 1+ drinks but did not binge or drink heavily); or current excessive drinker (i.e., binge drank and/or drank heavily).

Next, we identified consumption patterns by low, medium, or high consumption based on the average daily volume of alcohol consumed. We followed the CDC method of calculating cutpoints for the Alcohol-Related Disease Impact Tool (ARDI) [21], which uplifts modal volumes by accounting for binge drinking episodes via a process called “indexing” [22]. In addition to the BRFSS questions on quantity, frequency, and binge drinking frequency, this process used a question on drinking intensity (i.e., the maximum number of drinks consumed during a drinking occasion) [22]. We used the standardized cutpoints from ARDI [21], which defined risk levels as: low = 0 to ≤ 2 drinks for males and 0 to 1 drink for females; medium = > 2 to ≤ 4 drinks for males and > 1 and ≤ 2 drinks for females; and high = > 4 drinks for males or > 2 drinks for females.

Previous National and State Studies

The methods utilized in Sacks, et al. (2015) were based on Bouchery, et al. (2013) and Sacks, et al. (2013); we briefly describe them here. Bouchery, et al. (2013) was a comprehensive COI analysis that used national administrative and survey data for 2006. The team used the alcohol-attributable fractions (AAFs) from ARDI prior to July 2020 for chronic outcomes and conducted a literature review to generate AAFs for acute outcomes [13, 21]. These AAFs estimated the proportion of each of 54 conditions or injuries attributable to excessive drinking [13]. The AAFs were applied to 26 cost components across 3 categories: direct health care costs, indirect productivity losses, and other costs [9]. The counterfactual for cost studies using these AAFs is the population drinking at non-excessive levels (i.e., no binge, heavy, underage, or pregnant alcohol use).

In December 2011, the CDC convened an expert panel to apportion the cost of excessive alcohol use to the state level for 2006 [12]. Using a variety of allocators, each of the cost components from the national study was calculated at the state level [12]. The selected allocators included proxies for the level of underlying incidence (e.g., health care visits, traffic crashes) and prices (e.g., average wage) [12]. This method allowed cost comparisons across states without requiring detailed data from every state.

Building on this study, Sacks, et al. (2015) adjusted these 26 cost components from 2006 to 2010 by calculating scaling factors or “trends” based on changes in the underlying incidence (“incidence trend”) and price (“price trend”). Thus, each incidence trend equaled incidence_{06}/incidence_{10} and each price trend equaled price_{06}/price_{10}, where incidence_{06} was the incidence in 2010, incidence_{06} was the incidence in 2006, price_{06} was the price proxy in 2010, and price_{06} was the price proxy in 2006 [11].

Adjusting 2010 Costs to 2017

Sacks provided our team with detailed data for North Carolina for all 26 cost components of the 2010 cost estimate in the same 3 categories (i.e., direct health care costs, indirect/lost productivity costs, and other costs to society). Intangible costs, such as pain and suffering, were excluded. We updated Sacks, et al.’s formulas to adjust from 2010 to 2017.

Data selected for incidence and price for each of the cost components were based on the sources used by Sacks, et al. (2015), detailed previously [11]. In most cases, we used state-level equivalents. When state-specific data were unavailable, we used national or regional data and scaled by population. Although rare, some data were not yet avail-
able for 2017, and we used data for 2016 as a proxy in these instances. The data sources used for the incidence and price are detailed in the Supplemental Appendix, available online.

There were 2 instances in which our methods deviated from Sacks, et al. (2015). Instead of using total motor vehicle crashes for the incidence trend for motor vehicle crash costs, we used only alcohol-attributable crashes. We made this substitution because local data were available, and changes in alcohol-attributable crashes are likely a more valid indicator of changes in the underlying costs. Additionally, instead of adjusting the 2010 cost of the health insurance administration using incidence and price trends, we calculated the cost as a percentage of the combined cost of all the health care cost components as was done in Bouchery, et al. (2013). We selected this method because it was more conservative.

### TABLE 1. Estimated Costs of Excessive Drinking in Millions ($), North Carolina 2017

| Cost Component                               | Cost in 2010 (1) | Incidence Trend (2) | Price Trend (3) | Cost in 2017 (4) | (2) * (3) * (4) |
|---------------------------------------------|------------------|---------------------|----------------|-----------------|-----------------|
| Direct/Health Care                          | 128.86           |                     |                | 128.86          |                 |
| Indirect/Lost Productivity                  |                  |                     |                |                 |                 |
| Impaired Productivity at Work               | 2462.90          | 1.04                | 1.21           |                 |                 |
| Impaired Productivity at Home               | 195.26           | 1.14                | 1.13           |                 |                 |
| Absenteeism                                 | 183.73           | 1.53                | 1.21           |                 |                 |
| Impaired Productivity in Specialty Care     | 60.76            | 1.09                | 1.21           |                 |                 |
| Impaired Productivity While in Hospital     | 7.96             | 0.98                | 1.21           |                 |                 |
| Mortality                                   | 4036.44          | 1.46                | 1.21           |                 |                 |
| Incarceration of Perpetrators               | 235.77           | 0.92                | 1              |                 |                 |
| Crime Victims                               | 87.57            | 0.82                | 1.21           |                 |                 |
| FAS Productivity                            | 49.17            | 0.98                | 1.21           |                 |                 |
| Other                                       | 1357.57          |                     |                |                 |                 |
| Crime Victim Property Damage                | 17.55            | 0.80                | 1.21           |                 |                 |
| Corrections                                 | 459.17           | 0.96                | 1.21           |                 |                 |
| Alcohol Related Crimes                      | 38.22            | 0.53                | 1.21           |                 |                 |
| Violent and Property Crimes                 | 139.18           | 0.59                | 1.21           |                 |                 |
| Private Legal                               | 4.92             | 0.56                | 1.21           |                 |                 |
| Motor Vehicle Crashes                       | 609.17           | 1.06                | 1.21           |                 |                 |
| Fire Losses (Protection)                    | 80.45            | 1.18                | 1.21           |                 |                 |
| FAS - Special Education                     | 8.90             | 0.98                | 1.21           |                 |                 |
| Total                                       | 9716.61          |                     |                |                 |                 |

*Health Insurance Administration was calculated using the methods described in Bouchery, et al. (2013). See the Appendix for more details. Cost is in 2017 dollars.

### Total Cost of Alcohol Use

The total cost of alcohol use was calculated by summing all cost components.

### Apportioning Costs by Payer, Standard Drink, and County Payer

The total cost was allocated across 3 groups: drinkers, persons other than the drinker, and the government. Persons other than the drinker included private health insurers, employers, crime victims, and others. The proportional allocation was calculated using methods from Bouchery, et al. (2013) and Trangenstein and Jernigan [23]. See footnotes under Table A-3 in the Supplemental Appendix for detailed descriptions.

### Standard drink

The total gallons of absolute alcohol consumed in North Carolina was obtained from the National...
Institute on Alcohol Abuse and Alcoholism using alcohol beverage sales data from the Alcohol Epidemiologic Data System [24]. Total number of standard drinks consumed was calculated by converting gallons to grams at 3588.23 grams/gallon and then to standard drinks (dividing by 14 grams) [25]. The cost per standard drink was calculated by dividing the total cost by the number of standard alcoholic drinks consumed in North Carolina in 2017.

**County.** Total cost at the county level is expected to be largely proportional to population size, modified by the level of consumption and alcohol-attributable harms. There are several methods of apportioning, including the county-level proportion of alcohol-attributable deaths [4], alcohol (spirits) sales [26], and excessive drinking prevalence [27]. The results using these 3 methods were strongly correlated (12 pairwise Spearman, Kendall, and Pearson tests between 0.71 and 0.95). We ultimately selected the alcohol-attributable deaths because it was anticipated to have the lowest bias. Tables A-4 and A-5 in the Supplemental Appendix report county costs using all 3 methods.

**APPENDIX TABLE A-4. Costs of Excessive Drinking by County in Millions ($), 2017**

This table is available in its entirety in the online edition of the NCMJ.

| County         | Cost (Millions) |
|----------------|-----------------|
|                |                 |

**APPENDIX TABLE A-5. Costs of Excessive Drinking per County Resident in Dollars ($), 2017**

This table is available in its entirety in the online edition of the NCMJ.

| County         | Cost (Dollars) |
|----------------|----------------|
|                |                |

**Results**

**Drinking Patterns**

Overall, 54.4% (95% confidence interval (CI): 53.5%, 55.4%) of adults aged 18 and older were current abstainers; 31.4% (95% CI: 30.5%, 32.3%) were current, non-excessive drinkers; and 14.2% (95% CI: 13.5%, 14.9%) were current excessive drinkers in North Carolina in 2017 (Figure 1). Among current drinkers, nearly 1 in 3 (30.7%, 95% CI: 29.4%, 32.1%) drank excessively (Figure 1).

When investigating the prevalence of excessive drinking by sex and age, rates were higher among males in every age category: 18-to-34-year-olds (males: 28.5%, 95% CI: 26.0%, 31.1%; females: 17.7%, 95% CI: 15.7%, 20.0%, P < .001), 35-to-64-year-olds (males: 16.8%, 95% CI: 15.3%, 18.0%, females: 9.0%, 95% CI: 8.0%, 9.3%, P < .001), and those aged 65 and older (males: 7.6%, 95% CI: 6.1%, 9.3%; females: 2.1%, 95% CI: 1.5%, 2.9%, P < .001). When stratified by sex, prevalence of excessive drinking also declined with age (P < .001).

Overall, 84.9% (95% CI: 83.8%, 85.9%) of current drinkers were classified as low consumption (data not shown). About 1 in 10 (9.9%, 95% CI: 9.1%, 10.8%) were medium consumption, and 1 in 20 (5.2%, 95% CI: 4.5%, 6.0%) were high consumption. Consumption levels from alcohol use differed by sex (P < .001), with more males (6.4%, 95% CI: 5.5%, 7.6%) in the high-consumption category than females (3.7%, 95% CI: 2.9%, 4.7%).

**Total Cost of Excessive Drinking**

Excessive drinking cost North Carolina $9.72 billion in 2017 (Table 1). Direct health care costs were $1.04 billion, indirect/lost productivity costs were $7.32 billion, and other costs were $1.36 billion. The highest direct costs included specialty care for abuse and dependence ($419 million), hospitalization ($228 million), and health insurance administration ($129 million) (Table 1).

**Cost by Payer, Standard Drink, and County**

Of the total cost, 45.6% was paid by the government, 38.7% was paid by the drinker, and 15.7% was paid by someone else other than the drinker (Table 2). Of the $1.53 billion paid by someone else other than the drinker, 25.0% was paid by victims, 53.2% was paid by private and other insurance, and 21.8% was paid by others. The cost per standard drink was $2.09. By county, total costs from excessive drinking were highest in Mecklenburg ($712.8m), Wake (562.0m), and Guilford ($525.5m) counties and lowest in Camden ($9.7m), Tyrrell ($7.3m), and Hyde ($4.9m) counties (Figure 2, Table A-4).

**Discussion**

This study estimated the societal cost of excessive drinking from a public health perspective. Excessive drinking cost approximately $9.72 billion in North Carolina in 2017. This was a 38.3% relative increase since 2010, when the cost was $7.03 billion [11]. Adjusting this previous cost for price inflation (at a consumer price index of 1.12) would have yielded an estimate of $7.87 billion, explaining only 11.95% of this relative increase.

These cost data make plain that alcohol’s burden exerts a toll on many stakeholders who should, therefore, have an interest in minimizing these costs. In this analysis, treatment centers ($419.0m), prisons ($459.2m), hospitals ($228.2m), and health insurance companies ($129 million) paid some of the largest direct price tags. Most of the total costs derived from lost productivity, making them essentially opportunity costs. Consequently, they may or may not materialize as dollars spent. Still, these costs quantify the downstream consequences of excessive drinking on households, workplaces, and society. The minority of North Carolina adults (14.2%) who drank excessively paid less than 40% of the total cost, leaving the government to pay nearly $1...
out of every $2. Despite alcohol’s burden and the high toll on the state government, there has been vigorous debate about whether to “modernize” North Carolina’s alcohol laws by deregulating its physical availability [5, 28]. The research is clear that increased physical availability increases the population level of excessive drinking and related harms and costs [7, 29, 30].

In July 2019, a large “omnibus” alcohol bill that reformed alcohol availability passed in North Carolina [28]. For example, it allows drinkers to purchase more than one drink at a time and alcohol retailers to deliver beer and wine to people’s homes. The legislature also considered HB971, which would have disbanded North Carolina’s government monopoly on the wholesale and retail sale of spirits and recommended the state-run liquor stores open on Sundays. The costing methods used to inform HB971 only included costs to the industry and government, which means these estimates did not account for the costs to the public at large [5, 31]. The HB971 economic analysis demonstrated that its financial benefits would be concentrated mostly among alcohol wholesalers and retailers, and our analysis adds that the harms are spread more diffusely across society [5]. While HB971 did allocate additional proceeds to alcohol treatment and local government [5], alcohol use disorders are not the only harm that results from excessive drinking, and it is possible these revenues may be offset or diminished by rising costs from increasing consumption and related harms.

Building on these legislative changes, temporary executive orders during the coronavirus pandemic further deregulated alcohol availability, permitting spirits delivery and to-go

![Figure 1](image-url)

**FIGURE 1.** Prevalence of Current Abstention, Non-Excessive Drinking, and Excessive Drinking* in North Carolina, 2017 by Sex and Age

* Differences between males and females significant at P < .05.

* Excessive drinking includes binge drinking, heavy drinking, and any alcohol consumption by youth under age 21 years or pregnant women.

Note. This bar chart shows the percent of the adult population on the Y axis, defined as those aged 18 or older, and 6 age-sex strata along the X-axis (i.e., males 18–34 years, females 18–34 years, males 35–64 years, females 35–64 years, males 65+ years, and females 65+ years). This figure shows that the differences in the prevalence of excessive drinking between males and females in the 35–64-year-old stratum are significant, with a smaller proportion of females (versus males) drinking excessively. In addition, a smaller proportion of females aged 65+ drink excessively than males.

### TABLE 2.

| Cost Category       | Drinker | Victims | Private & Other Insurance | Others | Government | Total   |
|---------------------|---------|---------|---------------------------|--------|------------|---------|
| Health Care         | 51.81   | 4.01    | 373.26                    | 132.82 | 477.85     | 1,039.48|
| Lost Productivity   | 3,566.65| 360.45  | 111.78                    | 103.99 | 3,176.69   | 7,319.56|
| Other               | 142.59  | 17.55   | 328.34                    | 96.86  | 772.22     | 1,357.57|
| Total               | 3,761.05| 382.01  | 813.38                    | 333.67 | 4,426.49   | 9,716.61|
| % of Total          | 38.71   | 3.93    | 8.37                      | 3.43   | 45.56      |         |
sales [32, 33]. Similarly, these executive orders highlighted the economic benefits to the industry, without considering that alcohol may propagate transmission and determine COVID-19 severity through its deleterious effects on respiratory health and drinkers’ desire to socialize [34, 35].

The results of this study should be viewed in light of its limitations. The AAFs used in the 2010 study on which we based this analysis were developed using national-level data. North Carolina had the 13th-highest prevalence of excessive drinking in the United States in 2017 [36], so some of the assumptions underlying some of the AAFs may not generalize fully to North Carolina. Next, BRFSS alcohol consumption data provide lower estimates compared to other nationally representative surveys [37, 38]. We used BRFSS because it has the largest sample size and provides state-level datasets. Additionally, adjusting estimates to 2017 by scaling could over- or underestimate some cost components, and this method is more prone to error than a comprehensive costing study using complete administrative data would be. However, the volume of data required to conduct this type of study is burdensome, and this procedure permitted us to combine the scientific evidence with expert opinion to estimate this burden in the absence of these detailed data. In addition, 2017 incidence data were unavailable for 2 cost components—ambulatory care and drugs/services (likely due to a time lag for release)—so we used 2016 as a proxy. Relatedly, we scaled national incidence for other data sources, which could affect their accuracy. Still, we erred on the side of being conservative whenever possible and excluded subjective intangible costs (e.g., pain and suffering) that would have inflated these estimates.

Alcohol policy decisions are complex, often involving a multitude of diverse stakeholders with competing interests. Public health is one of these stakeholders, and societal cost analyses can inform these conversations. In the context of the ongoing alcohol policy debate in North Carolina, this manuscript builds on a small literature of local cost of alcohol studies that provide policy-relevant data. These results underscore the potential opportunity of controls on the physical availability of alcohol, such as government monopolies and reduced hours and days of sale, as evidence-based strategies [39, 40] for North Carolina to mitigate the burden of excessive drinking on society.

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