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# Alcohol-Attributable Medical Costs in Commercially Insured and Medicaid Populations

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**Introduction:** Despite its social acceptance, excessive alcohol use remains among the top causes of preventable deaths in the U.S. Although there is a recognition of alcohol-related health and social costs, there are no current studies quantifying the medical costs incurred under health plans.

**Methods:** This study estimates the direct medical costs attributable to excessive alcohol use using claims records from a large national insurer. The sample consists of adults with commercial insurance and Medicaid between 2008 and 2019. A case-control matched study design is used to compare individuals with a condition considered 100% attributable to alcohol by the Centers for Disease Control and Prevention with similar individuals. Medical care use and costs are examined over a 12-month follow-up. Costs are broken down by healthcare setting and health conditions as defined by the Centers for Disease Control and Prevention's Alcohol-Related Disease Impact diagnoses codes.

**Results:** We find that having a diagnosis attributable to alcohol is associated with higher annual per-person healthcare expenditures in both commercially insured and Medicaid-insured participants by $14,918 (95% CI=$14,540, $15,297) and $4,823 (95% CI=$4,489, $5,158), respectively. We find that 60%–75% of the additional costs of excessive alcohol use are driven by heart disease and stroke; conditions of the liver, gallbladder, and pancreas; and certain cancers as well as acute conditions that may be attributable to alcohol.

**Conclusions:** The findings suggest that public and private initiatives to target people vulnerable to the harms of excessive alcohol use may potentially help to cut down significant costs on the already strained healthcare system in the U.S.



## INTRODUCTION

Excessive alcohol use[a] is among the leading causes of preventable deaths in the U.S.[1] The Centers for Disease Control and Prevention (CDC) estimates that 95,000 people die from alcohol-related causes annually and that the total cost of excessive alcohol use to the U.S. economy was $249 billion in 2010.[1] Approximately half of the deaths attributable to alcohol were caused by chronic conditions that involved medium or high average daily alcohol consumption.[1] Binge drinking is responsible for the other half of preventable deaths.[1] A total of 1 in 6 adults in the U.S. binge drinks once a week, and they

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make up for three quarters of the costs because of excessive alcohol[a] use.[2]

The emergence of coronavirus disease 2019 (COVID-19) and stay-at-home orders further exacerbated the already rising rates of excess alcohol intake.[3–6] A total of 23% of Americans reported drinking more alcohol to cope with stress during COVID-19.[4] In the U.S., the frequency of alcohol consumption increased by 14% between April 2020 and June 2020, and alcohol problems increased during May 2020 and March 2021.[5,6] The rate of alcohol withdrawal in hospitalized patients was found to be consistently higher in 2020 than in both 2019 and the average of 2018 and 2019.[7]

Excessive alcohol use is detrimental to health both in the short and long term.[8,9] Long-term use of excess alcohol has been shown to be associated with psychiatric disorders, liver and heart diseases, stomach ulcers, stroke, cancer, and poor pregnancy outcomes.[8–11] Studies show that even light alcohol consumption increases the risk of certain cancers.[12–15] These conditions lead to significant healthcare use and costs. Visits to the emergency department (ED) because of excess alcohol use increased by 47% from 1,223 to 1,802 visits per 100,000 persons in the population between 2006 and 2014, and the costs of associated ED visits increased by 272%.[16] In 2010, a total of $28 billion of excessive alcohol use cost was attributed to medical spending.[17]

Estimating the total cost of excessive alcohol use involves more than costs to one's physical health because it may pose high costs to society through alcohol-attributable accidents, crimes, and loss of workplace productivity, as well as costs attributed to mental health conditions.[17–20] Although there is a large body of literature on alcohol's societal costs,[19–23,9,24,25] to the best of our knowledge, there are no current studies quantifying the medical costs incurred under health plans. This study aims to estimate the direct medical costs of excessive alcohol conditions to health payers using claims data from the HealthCore Integrated Research Database (HIRD).[b]

# METHODS

## Study Sample

The study utilized a large commercial administrative claims database, the HIRD, which contains medical, pharmacy, and laboratory data on >80 million enrollees in 14 geographically dispersed health insurance plans across the U.S. Members are enrolled in different types of health insurance plans, including HMO, point of service, preferred provider organizations, and consumer-driven plans. Previous analysis indicated that the HIRD over-represented the U.S. Census Bureau data for ages between 30 and 64 years and for the Midwest region and under-represented the U.S. Census Bureau data for age groups >65 years and for the South region. The skewed age distribution and misrepresentation of U.S. geographic regions in HIRD over-represent a currently employed population who are middle-aged individuals and their dependents. The samples used in this study did not include capitated plans, and the Medicaid sample included individuals dually enrolled in Medicaid and Medicare.

We chose a retrospective cohort study design using 2:1 exact matching on the basis of 9 observable characteristics. The sample of patients was aged ≥18 years at the date of diagnosis, with diagnosis codes for any condition that is listed as 100% alcohol attributable between January 1, 2008 and June 1, 2019. We refer to this group as the case.

## Measures

We used CDC's Alcohol-Related Disease Impact application's measure of Alcohol-Attributable Fraction (AAF) to assign conditions that are 100% alcohol attributable (e.g., alcohol use disorder, alcoholic liver disease). AAF is a measure of attribution of a medical condition to alcohol.[c,26] The first day of diagnosis with a 100% alcohol-attributable condition within a 6-month continuous medical insurance coverage segment was set as the index date to allow a washout period. All case patients were required to have at least 12 months of continuous medical insurance coverage after the index date. Appendix Tables 1 through 6 show the diagnosis codes used in this study.

The final sample size consisted of 251,586 commercially insured patients and 36,291 Medicaid patients. We conducted analyses separately for commercially insured and Medicaid-insured patients because of the large differences between commercial and Medicaid reimbursement rates.

This study was conducted in full compliance with relevant provisions of the Health Insurance Portability and Accountability Act. Because researchers only used analytic files derived from a limited data set to perform the analyses as defined by the Privacy Rule 45CFR 164.514(e), no waiver of informed consent or exemption was needed from an IRB.

## Statistical Analysis

Following established methods of quantifying disease-attributable costs, we used 2:1 exact matching without replacement to improve the balance of the case and control and reduce the bias from the estimated effect of having an alcohol-related diagnosis that results from long-term excessive alcohol use on healthcare costs and utilization.[27–30] Each person who had a 100% alcohol-attributable condition during the study period was matched with 2 distinct persons who never had any diagnosis with any of the alcohol-attributable conditions regardless of their AAF score. Specifically, we matched case and control patients with regard to the following

[a]*Excessive alcohol consumption* was defined as follows: binge drinking (≥4 drinks per occasion for a woman and ≥5 drinks per occasion for a man), heavy drinking (>1 drink per day on average for a woman and >2 drinks per day on average for a man), any alcohol consumption by youth aged <21 years, and any alcohol consumption by pregnant women.

[b]This study used a sample of commercially insured patients from all states and Medicaid insured patients from Colorado, Nevada, New York, Ohio.

[c]Diagnosis codes are listed in Appendix (available online).

characteristics: birth year (±2 years), sex, state of residence at the start of their medical insurance, Elixhauser comorbidity index (ECI) categories, ZIP code–level SES index score quartile at the start of their medical insurance, health plan characteristics and length of continuous insurance coverage as of the start of their insurance coverage, and length of insurance coverage before the index date. For the time-varying characteristics such as ECI score, we performed matching on the basis of ECI score categories within the first 6 months of medical insurance coverage to reduce overmatching bias because alcohol exposure by itself can influence these characteristics. Our estimated coefficient represents the average of within-group differences in healthcare costs where the group represents the case and its assigned matched controls.

We assessed the following healthcare costs and utilization 12 months after the index date: total costs/counts of healthcare service visits; total costs and visits broken by the care setting and separating the costs by conditions related to alcohol (cancer, heart disease, and stroke), conditions of liver, gallbladder, and pancreas; partially alcohol-attributable acute conditions (i.e., motor vehicle crashes); and all other acute conditions that are 100% alcohol attributable (i.e., alcohol poisoning). All hypothesis tests were 2 sided with statistical significance levels at $p \leq 0.05$.

## RESULTS

We observe differences in patient characteristics diagnosed with a 100% alcohol-attributable condition between commercial and Medicaid samples (Table 1). The average age in the commercially insured sample is 6 years older than in the Medicaid-insured sample (46 vs 40), and they are less likely to be women (33% vs 44%).

Medicaid-insured patients are least likely to reside in the fourth quartile of the socioeconomic index and most likely to live in the first quartile. The relationship is reversed in commercially insured patients, who are more likely to reside in the fourth quartile and least likely to be in the first quartile. A total of 58% of commercially insured patients have no comorbid conditions in the first 6 months of their medical insurance coverage, whereas only 36% of Medicaid-insured patients have no comorbid conditions. Half of Medicaid-insured patients have 1 or 2 comorbid conditions. These findings show that commercially insured patients are more likely to be male, older, and healthier.

Within 12 months of their diagnosis, commercially insured people who were diagnosed with a 100% alcohol-attributable condition, namely the case group, incur an additional $14,918 (95% CI=14,540, $15,297; $p<0.001$) compared with the control group (Table 2). More than half of this cost differential is driven by inpatient settings (difference=$9,375; 95% CI=$9,075, $9,675; $p<0.001$), followed by outpatient settings (difference=$4,388; 95% CI=$4,211, $4,563; $p<0.001$) and ED settings (difference=$1,156; 95% CI=$1,128, $1,184; $p<0.001$). There are also meaningful differences in healthcare utilization, although their ranking with respect to the size of the effect is different from those in costs. On average, a person has 11.9 more outpatient visits (95% CI=11.68, 12.10; $p<0.001$), 0.42 more inpatient visits (95% CI=0.415, 0.429; $p<0.001$), and 0.38 more ED visits (95% CI=0.371, 0.385; $p<0.001$) within 12 months of being observed with a 100% alcohol-attributable condition for the first time in HIRD, or any diagnosis of alcohol-attributable conditions during the same time frame. This translates to the idea that being diagnosed with an alcohol-attributable condition is associated with a twofold increase in healthcare utilization overall and a fivefold increase in inpatient and ED utilization. A total of 68% of the cost differential is explained by conditions that are 100% attributable to alcohol, and the majority of them are from costs of chronic conditions (i.e., alcoholic liver disease, alcohol-induced pancreatitis, alcohol dependence syndrome). Appendix Tables 7 and 8 (available online) show the differences in healthcare costs between case and control 2 years after the initial diagnosis.

Approximately 75% of the cost differential between case and control can be explained by 5 categories of conditions in the commercially insured sample: heart disease and stroke (difference=$5,468; 95% CI=$5,229, $5,706; $p<0.001$); conditions of the liver, gallbladder, and pancreas (difference=$2,089; 95% CI=$1,931, $2,246; $p<0.001$); acute conditions that are partially attributable to alcohol (difference=$2,068; 95% CI=$1,926, $2,209; $p<0.001$); all other acute conditions that are 100% alcohol attributable (difference=$830; 95% CI=$720, $939; $p<0.001$); and cancer (difference=$680; 95% CI=$578, $781; $p<0.001$).

Correspondingly to the commercially insured, we see significant cost differentials between the case and control in the Medicaid-insured sample (Table 3). On average, a person diagnosed with a 100% alcohol-attributed condition incurs additional healthcare costs amounting to $4,823 (95% CI=$4,489, $5,158; $p<0.001$) within the 12 months of their diagnosis compared with a similar person insured by Medicaid. Most of this cost differential occurs in inpatient settings (difference=$2,971; 95% CI=$2,713, $3,229; $p<0.001$), followed by outpatient settings (difference=$1,439; 95% CI=$1,256, $1,623; $p<0.001$) and ED settings (difference=$413; 95% CI=$388, $438; $p<0.001$). The utilization differences are comparable with those of the commercially insured. Diagnosis of a 100% alcohol-attributable condition is associated with an increase in the counts of healthcare utilization (difference=14.5; 95% CI=13.5−15.6; $p<0.001$). Most of the utilization difference is a result of an increase in outpatient service utilization. After 12 months of having been diagnosed with a 100% alcohol-attributable condition,

**Table 1.** Summary Statistics

| Person characteristics | Commercially insured | | Medicaid | |
|---|---|---|---|---|
| | Case (*n*=83,862). mean (SD), (95% CI) | Control (*n*=167,724), mean (SD), (95% CI) | Case (*n*=12,097), mean (SD), (95% CI) | Control (*n*=24,194), mean (SD), (95% CI) |
| Demographic characteristics | | | | |
| Age | 46.4, (14.1) | 46.4, (14.2) | 40.2, (12.3) | 40.3, (12.5) |
| Female | 33.1%, (32.7%, 33.4%) | 33.1%, (32.9%, 33.3%) | 44.2%, (43.3%, 45.1%) | 44.0%, (43.4%, 44.6%) |
| Region | | | | |
| Northeast | 20.5%, (20.2%, 20.7%) | 20.5%, (20.3%, 20.7%) | 62.7%, (61.8%, 63.5%) | 62.6%, (62.0%, 63.2%) |
| Midwest | 24.2%, (23.9%, 24.5%) | 24.2%, (24.0%, 24.4%) | 0.2%, (1.4%, 3.1%) | 0.2%, (0.2%, 0.3%) |
| South | 28.5%, (28.2%, 28.8%) | 28.5%, (28.3%, 28.7%) | 0.00%, (0.00%, 0.00%) | 0.00%, (0.00%, 0.00%) |
| West | 26.8%, (26.5%, 27.1%) | 26.8%, (26.6%, 27.6%) | 37.2%, (36.6%, 37.8%) | 37.1%, (36.3%, 38.0%) |
| Socioeconomic quartile | | | | |
| First quartile | 12.0%, (11.8%, 12.3%) | 12.0%, (11.9%, 12.2) | 27.5%, (26.7%, 28.3%) | 27.7%, (27.1%, 28.2%) |
| Second quartile | 20.4%, (20.1%, 20.7%) | 20.5%, (20.3%, 20.7%) | 21.3%, (20.6%, 22.0%) | 21.4%, (20.9%, 21.9%) |
| Third quartile | 27.3%, (27.0%, 27.6%) | 27.3%, (27.1%, 27.5%) | 22.1%, (21.4%,22.9%) | 22.0%, (21.5%,22.5%) |
| Fourth quartile | 37.0%, (36.7%, 37.3%) | 36.9%, (36.7%, 37.2%) | 19.3%, (18.6%, 20.0%) | 19.2%, (18.7%, 19.6%) |
| Unknown/missing | 3.3%, (3.2%, 3.4%) | 3.3%, (3.2%, 3.4%) | 9.7%, (9.3%, 10.3%) | 9.8%, (9.4%, 10.1%) |
| Elixhauser comorbidity index | | | | |
| 0 | 58.4%, (58.1%, 58.7%) | 58.3%, (58.0%, 58.5%) | 35.7%, (34.8%, 36.5%) | 35.0%, (34.5%, 35.6%) |
| 1–2 | 33.1%, (32.8%, 33.4%) | 33.2%, (32.9%, 33.4%) | 50.1%, (49.2%, 51.0%) | 50.3%, (49.7%, 50.9%) |
| 3–4 | 6.9%, (6.7%, 7.1%) | 7.0%, (6.8%, 7.1%) | 11.5%, (10.9%, 12.1%) | 11.9%, (11.5%, 12.3%) |
| ≥5 | 1.6%, (1.5%, 1.7%) | 1.6%, (1.6%, 1.7%) | 2.6%, (2.4%, 3.0%) | 2.8%, (2.6%, 3.0%) |
| Health plan characteristics | | | | |
| Primary | 73.6%, (73.3%, 73.9%) | 73.7%, (73.5%, 73.9%) | — | — |
| Fully insured | 26.1%, (25.8%, 26.4%) | 26.0%, (25.8%, 26.2%) | — | — |
| Commercial | 88.9%, (88.7%, 89.1%) | 88.9%, (88.8%, 89.1%) | — | — |
| Individual | 7.7%, (7.5%, 7.8%) | 7.7%, (7.6%, 7.8%) | — | — |
| Medicare | 3.4%, (3.3%, 3.5%) | 3.4%, (3.3%, 3.5%) | — | — |
| PPO | 75.6%, (75.3%, 75.9%) | 75.6%, (75.4%, 75.8%) | — | — |
| HMO | 14.5%, (14.3%, 14.7%) | 14.5%, (14.4%, 14.7%) | — | — |
| CDHP | 9.8%, (9.6%, 10.0%) | 9.8%, (9.7%, 9.9%) | — | — |
| Unknown/other | 0.01%, (0.00%, 0.02%) | 0.01%, (0.00%, 0.02%) | — | — |

CDHP, consumer-driven health plan; PPO, preferred provider organization.

healthcare utilization is found to have increased in outpatient, inpatient, and ED settings by 13.4 (95% CI=12.3, 14.5; $p<0.001$), 0.41 (95% CI=0.39, 0.43; $p<0.001$), and 0.78 (95% CI=0.74, 0.82; $p<0.001$) in the Medicaid-insured sample, respectively.

In the Medicaid-insured sample, approximately 60% of the total cost differential is tied to 4 categories of conditions: heart disease and stroke (difference=$1,215; 95% CI=$1,026, $1,405; $p<0.001$); acute conditions that are partially attributable to alcohol (difference=$741; 95% CI=$620, $861; $p<0.001$); conditions of the liver, gallbladder, and pancreas (difference=$528; 95% CI= $400, $656; $p<0.001$) and); and all other acute conditions that are 100% alcohol attributable (difference= $386; 95% CI=$256, $517; $p<0.001$).

Contrary to the commercially insured, in the Medicaid-insured sample, there is no significant cost difference resulting from cancer-related health services between the case and control. We also observe that in the commercially insured sample, cost differences from heart disease and stroke make up a larger share of the cost difference than in the Medicaid-insured sample (37% vs 25%). In general, for the Medicaid-insured sample, we observe that acute conditions make up a larger share of the overall cost differential than in the commercially insured sample (23% vs 19%), whereas chronic conditions such as heart disease and stroke; liver, gallbladder, and pancreas; and cancer drive the cost differences relatively more in the commercially insured sample.

**Table 2.** Total Healthcare Expenditures and Utilization 12 Months After the Index Date of Alcohol-Related Diagnosis in Commercially Insured Sample

| Costs and utilization | Case | | Control | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | Difference | SE | 95% CI | *p*-value |
| Total costs ($)[a] | | | | | | | | |
| All settings | 20,746.8 | 53,680.5 | 5,828.4 | 25,289.6 | 14,918.4 | 193.1 | (14,540, 15,297) | **0.000** |
| Outpatient visits | 8,106.8 | 23,615.8 | 3,719.3 | 16,038.1 | 4,387.5 | 89.8 | (4,211, 4,563) | **0.000** |
| Inpatient visits | 11,155.9 | 43,128.8 | 1,781.0 | 16,741.0 | 9,375.0 | 152.9 | (9,075, 9,675) | **0.000** |
| Emergency room visits | 1,484.1 | 3,955.8 | 328.1 | 1,671.2 | 1,155.9 | 14.2 | (1,128, 1,184) | **0.000** |
| Plan-paid amount ($) | | | | | | | | |
| All settings | 17,195.4 | 49,456.7 | 4,505.4 | 21,911.0 | 12,690.0 | 177.3 | (12,342, 13,038) | **0.000** |
| Outpatient visits | 6,543.3 | 21,734.4 | 2,785.4 | 13,300.3 | 3,757.9 | 81.3 | (3,599, 3,917) | **0.000** |
| Inpatient visits | 9,525.8 | 39,808.0 | 1,483.2 | 15,131.8 | 8,042.6 | 141.2 | (7,766, 8,319) | **0.000** |
| Emergency room visits | 1,126.3 | 3,470.8 | 236.7 | 1,327.3 | 889.6 | 12.4 | (865.4, 913.8) | **0.000** |
| Utilization, counts | | | | | | | | |
| Total counts | 25.0 | 30.2 | 12.3 | 18.7 | 12.69 | 0.1 | (12.47, 12.90) | **0.000** |
| Outpatient visits | 24.0 | 29.8 | 12.1 | 18.5 | 11.89 | 0.1 | (11.68, 12.10) | **0.000** |
| Inpatient visits | 0.5 | 1.0 | 0.1 | 0.3 | 0.42 | 0.0 | (0.415, 0.429) | **0.000** |
| Emergency room visits | 0.5 | 1.0 | 0.1 | 0.5 | 0.38 | 0.0 | (0.371, 0.385) | **0.000** |
| Chronic 100% attributable costs ($) | | | | | | | | |
| Total amount | 10,113.5 | 35,242.2 | 8.1 | 583.9 | 10,105.4 | 121.7 | (9,867, 10,344) | **0.000** |
| Plan-paid amount | 8,404.1 | 32,538.2 | 6.5 | 521.4 | 8,397.6 | 112.4 | (8,177, 8,618) | **0.000** |
| Acute 100% attributable costs ($) | | | | | | | | |
| Total amount | 36.8 | 1,616.7 | 0.6 | 239.9 | 36.2 | 5.6 | (25.19, 47.20) | **0.000** |
| Plan-paid amount | 29.1 | 1,470.9 | 0.5 | 223.5 | 28.6 | 5.1 | (18.55, 38.58) | **0.000** |
| Other alcohol-related costs ($) | | | | | | | | |
| Cancer | 934.9 | 14,382.4 | 255.1 | 5,908.4 | 679.7 | 51.7 | (578.3, 781.2) | **0.000** |
| Heart disease and stroke | 6,933.0 | 34,464.2 | 1,465.5 | 13,177.5 | 5,467.5 | 121.7 | (5,229, 5,706) | **0.000** |
| Liver, gallbladder, and pancreas | 2,218.2 | 23,106.3 | 129.7 | 3,411.7 | 2,088.6 | 80.2 | (1,931, 2,246) | **0.000** |
| All other acute-related conditions | 957.7 | 15,683.0 | 152.7 | 7,234.4 | 829.5 | 55.8 | (720.2, 938.7) | **0.000** |
| Acute Conditions, not 100% attributable | 2,306.6 | 20,451.7 | 239.1 | 6,574.7 | 2,067.5 | 72.4 | (1,926, 2,209) | **0.000** |

*Note:* Boldface indicates statistical significance ($p<0.05$).
[a]Total costs are the sum of patient-paid and plan-paid amounts, and all costs are adjusted to 2020 U.S. dollars using the U.S. medical care inflation rate.

Tables 4 and 5 show the cost differentials by age groups. Alcohol-attributable healthcare costs were $11,624 (95% CI=$11,164, $12,084; $p<0.001$), $18,074 (95% CI=$17,455, $18,693; $p<0.001$), and $13,848 (95% CI=$12,481, $15,216; $p<0.001$) among those aged 18−44 years, 45−64 years, and ≥65, respectively, for the commercially insured sample. For the Medicaid-insured sample, additional costs were $3,852 (95% CI=$3,517, $4,188; $p<0.001$) and $6,341 (95% CI=$5,659, $7,023; $p<0.001$) among those aged 18−44 years and 45−64 years, respectively.

## DISCUSSION

We find that 1 year after the diagnosis of a condition attributable to alcohol, the additional medical spending is estimated to be $14,918 and $4,823 per person in commercially insured and Medicaid-insured populations, respectively. Using claims data, we find the prevalence of a 100% alcohol-attributable diagnosis to be 1.4% for commercially insured and 2.2% for Medicaid-insured samples between 2020 and 2021. We note that these prevalence rates are lower than the rates the literature reports, which vary between 12.7% and 5.6% depending on the data set.[31,32] The discrepancy between the rate of reported alcohol use disorder (AUD) from surveys and the rate of actual clinical diagnoses may be revealing the extent of underdiagnosis of AUD. Overall, these findings, along with findings from literature studying the cost-effectiveness of programs to treat AUD, suggest that public and private initiatives to help people vulnerable to harms of excess alcohol may potentially help to decrease significant costs on the already strained healthcare system in the U.S.[33−36]

**Table 3.** Total Healthcare Expenditures and Utilization 12 Months After the Index Date of Alcohol-Related Diagnosis in Medicaid-Insured Sample

| | Case | | Control | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Costs and utilization** | **Mean** | **SD** | **Mean** | **SD** | **Difference** | **SE** | **95% CI** | ***p*-value** |
| Total costs ($)[a] | | | | | | | | |
| All settings | 8,453.7 | 16,995.6 | 3,630.3 | 12,459.9 | 4,823.4 | 170.8 | (4,489, 5,158) | **0.000** |
| Outpatient visits | 3,847.9 | 8,814.6 | 2,408.6 | 8,185.9 | 1,439.3 | 93.6 | (1,256, 1,623) | **0.000** |
| Inpatient visits | 4,032.7 | 13,217.9 | 1,061.4 | 8,427.9 | 2,971.3 | 131.6 | (2,713, 3,229) | **0.000** |
| Emergency room visits | 573.1 | 1,303.7 | 160.3 | 777.8 | 412.8 | 12.6 | (388.2, 437.5) | **0.000** |
| Plan-paid amount ($) | | | | | | | | |
| All settings | 8,299.1 | 16,651.4 | 3,481.9 | 11,910.4 | 4,817.2 | 166.6 | (4,491, 5,144) | **0.000** |
| Outpatient visits | 3,772.0 | 8,751.4 | 2,335.1 | 7,949.2 | 1,436.9 | 92.4 | (1,256, 1,618) | **0.000** |
| Inpatient visits | 3,962.8 | 12,840.3 | 998.4 | 7,991.5 | 2,964.4 | 127.3 | (2,715, 3,214) | **0.000** |
| Emergency room visits | 564.3 | 1,262.5 | 148.4 | 655.3 | 415.9 | 12.0 | (392.4, 439.4) | **0.000** |
| Utilization, counts | | | | | | | | |
| Total counts | 33.9 | 51.9 | 19.3 | 45.9 | 14.55 | 0.6 | (13.47, 15.64) | **0.000** |
| Outpatient visits | 32.3 | 51.6 | 18.9 | 45.8 | 13.37 | 0.6 | (12.29, 14.45) | **0.000** |
| Inpatient visits | 0.5 | 1.2 | 0.1 | 0.5 | 0.41 | 0.0 | (0.387, 0.432) | **0.000** |
| Emergency room visits | 1.1 | 2.1 | 0.3 | 1.0 | 0.78 | 0.0 | (0.738, 0.816) | **0.000** |
| Chronic 100% attributable costs ($) | | | | | | | | |
| Total amount | 3,914.2 | 10,601.1 | 2.8 | 290.5 | 3,911.3 | 96.4 | (3,722, 4,100) | **0.000** |
| Plan-paid amount | 3,858.0 | 10,576.8 | 2.8 | 290.5 | 3,855.1 | 96.2 | (3,667, 4,044) | **0.000** |
| Acute 100% attributable costs ($) | | | | | | | | |
| Allowed amount | 3.3 | 243.0 | 0.0 | 0.8 | 3.3 | 2.2 | (−1.001, 7.659) | 0.132 |
| Plan-paid amount | 3.3 | 243.0 | 0.0 | 0.8 | 3.3 | 2.2 | (−1.001, 7.659) | 0.132 |
| Other alcohol-related costs ($) | | | | | | | | |
| Cancer | 192.3 | 4,646.3 | 137.9 | 4,731.4 | 54.4 | 51.4 | (−46.40, 155.2) | 0.290 |
| Heart disease and stroke | 1,901.9 | 9,815.9 | 686.5 | 6,450.3 | 1,215.4 | 96.6 | (1,026, 1,405) | **0.000** |
| Liver, gallbladder, and pancreas | 624.1 | 6,806.4 | 96.0 | 2,865.4 | 528.0 | 65.5 | (399.7, 656.4) | **0.000** |
| All other acute-related conditions | 539.5 | 6,632.9 | 173.0 | 4,703.5 | 386.3 | 66.6 | (255.8, 516.8) | **0.000** |
| Acute conditions, not 100% attributable | 873.5 | 6,153.6 | 133.0 | 3,955.0 | 740.5 | 61.5 | (620.1, 861.0) | **0.000** |

Boldface indicates statistical significance ($p<0.05$).
[a]Total costs are the sum of patient-paid and plan-paid amounts, and all costs are adjusted to 2020 U.S. dollars using the U.S. medical care inflation rate.

**Table 4.** Total Health Expenditures 12 Months After the Index Date of Alcohol-Related Diagnosis in Commercially Insured Sample by Different Age Groups

| **Ages: 18−44 years** | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Case, *n*=36,010** | | **Control, *n*=72,020** | | | | | |
| **Mean** | **SD** | **Mean** | **SD** | **Difference** | **SE** | **95% CI** | ***p*-value** |
| 15,639.2 | 42,196.0 | 4,015.2 | 20,613.8 | 11,624.0 | 234.9 | (11,163.7, 12,084.4) | **0.000** |
| Ages: 45−64 years | | | | | | | |
| Case, *n*=40,192 | | Control, *n*=80,384 | | | | | |
| Mean | SD | Mean | SD | Difference | SE | 95% CI | *p*-value |
| 24,873.9 | 61,274.6 | 6,799.9 | 25,914.3 | 18,074.0 | 316.0 | (17,454.7, 18,693.4) | **0.000** |
| Ages: ≥65 years | | | | | | | |
| Case, *n*=7,660 | | Control, *n*=15,320 | | | | | |
| Mean | SD | Mean | SD | Difference | SE | 95% CI | *p*-value |
| 23,102.5 | 57,101.7 | 9,254.5 | 38,062.1 | 13,848.0 | 697.6 | (12,480.5, 15,215.5) | **0.000** |

*Note:* Boldface indicates statistical significance ($p<0.05$).
Total costs are the sum of patient-paid and plan-paid amounts, and all costs are adjusted to 2020 U.S. dollars using the U.S. medical care inflation rate.

**Table 5.** Total Health Expenditures 12 Months After the Index Date of Alcohol-Related Diagnosis in Medicaid-Insured Sample by Different Age Groups

| Ages: 18–44 years | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Case, *n*=7,458** | | **Control, *n*=14,916** | | | | | |
| **Mean** | **SD** | **Mean** | **SD** | **Difference** | **SE** | **95% CI** | ***p*-value** |
| 6,830.2 | 12,765.7 | 2,977.8 | 10,447.5 | 3,852.4 | 171.3 | (3,516.8, 4,188.2) | **0.000** |
| Ages: 45–64 years | | | | | | | |
| Case, *n*=4,594 | | Control, *n*=9,188 | | | | | |
| Mean | SD | Mean | SD | Difference | SE | 95% CI | *p*-value |
| 10,934.7 | 21,619.5 | 4,593.5 | 14,952.4 | 6,341.2 | 347.9 | (5,659.2, 7,023.3) | **0.000** |
| Ages: ≥65 years | | | | | | | |
| Case, *n*=45 | | Control, *n*=90 | | | | | |
| Mean | SD | Mean | SD | Difference | SE | 95% CI | *p*-value |
| 24,224.4 | 40,684.7 | 13,444.6 | 23,805.5 | 10,779.8 | 5,836.3 | (−982.6, 22,542.1) | 0.071 |

*Note:* Boldface indicates statistical significance ($p<0.05$).
Total costs are the sum of patient-paid and plan-aid amounts, and all costs are adjusted to 2020 U.S. dollars using the U.S. medical care inflation rate.

Our study also finds that in the commercially insured population, alcohol-attributable costs are relatively stable across ages—starting from an additional $11,624 for the youngest adults and peaking for those aged 45–64 years at $18,074. The decreased cost differential for those aged ≥65 years can be explained by low Medicare Advantage payments in the commercially insured sample. The cost burden observed in younger adults provides an economic rationale for investing in AUD treatment interventions early on. In the Medicaid-insured population, although prices for health care paid by each age group are the same, we observe a consistent increase in alcohol-attributable costs with age.

Alcohol-attributable healthcare costs in the Medicaid-insured sample were meaningfully lower than in the commercially insured sample. This can be explained by reimbursement differences in commercial insurance and Medicaid insurance as well as by the Medicaid-insured sample being younger.[37,38] Despite lower per-patient costs to Medicaid health plans, health services payers can still benefit significantly from interventions targeting vulnerable individuals insured by Medicaid. Previous research has shown that although people with higher SES may consume similar or greater amounts of alcohol than people with lower SES, the latter group seems to bear a disproportionate burden of negative alcohol-related consequences.[39,40]

The level of alcohol treatment access is alarming, especially for those who medically need it the most.[41] Payers of health services may financially benefit from programs that target those vulnerable to alcohol harm before they develop alcohol-attributable chronic conditions. These programs may include provider incentives for surveillance and screening of problematic use of alcohol among their patients. Although progress has been reported in terms of access to substance use disorder treatments for some populations, especially among Medicaid enrollees, trends in the actual use of the treatments are improving very slowly and call for renewed efforts in this area.[42]

## Limitations

Study samples may not be representative of those with excessive alcohol consumption and those without alcohol use disorder issues because of identification through diagnosis codes reported in claims data. In addition, if the insured member had been diagnosed under a different health insurance carrier, the index date may not be the first date of alcohol-related diagnosis. Requiring at least 12 months of continuous medical eligibility may have also created a selective sample.

Our study design is limited to establishing an association between the presence of diagnoses and additional healthcare costs—we acknowledge that the results might be confounded by behaviors co-occurring with excessive drinking. Although we performed matching on time-varying characteristics at the earliest date we observed the subjects, we might not have eliminated potential overmatching because some of the factors used for matching are themselves associated with exposure to excessive alcohol over time.

This study was limited to estimating the healthcare costs attributable to excess alcohol to the health services payers, specifically health plans and employers, and determined to be directly attributable to alcohol

following CDC's Alcohol-Related Disease Impact Methodology. Although alcohol use disorder can have further impacts on health (e.g., AUD leading to poor prognosis on nonalcohol-related conditions), conditions outside of those indicated by CDC were out of scope for our study.

## CONCLUSIONS

This study estimated the annual per-person cost of healthcare spending associated with having an alcohol-related diagnosis using claims data. Diagnosis of a 100% alcohol-attributable condition was associated with higher healthcare costs in the following year both in commercially insured and Medicaid-insured populations, with most of the additional costs driven by heart disease, stroke, conditions of the liver, gallbladder, and pancreas, as well as certain cancers.

Alcohol continues to be among the most widespread and costly substances in the U.S., especially during the COVID-19 pandemic. Owing to its social acceptance and the long time period for its chronic effects to appear, alcohol may seem less harmful than other misused substances. As healthcare costs and excessive drinking continue to rise, health service payers may benefit from developing programs and improving access to treatment for those who are most vulnerable to excessive alcohol use.

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## SUPPLEMENTARY MATERIALS

Supplementary material associated with this article can be found in the online version at doi:10.1016/j.focus.2022.100036.

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