Article from

2020 Living to 100 Call for Essays

Alcohol and Mortality: An Actuarial Issue

April 2020

Contents

Alcohol and Mortality: An Actuarial Issue

Sam Gutterman

The consumption of alcohol is an often-overlooked behavioral mortality risk factor, especially compared to the attention given smoking and obesity. Nevertheless, it needs to be addressed, as its overuse represents a significant health risk. The objective of this essay is to describe its prevalence and associated risks and concerns.

The harmful use of alcohol can contribute or cause injury, violence and poisoning, as well as noncommunicable (e.g., liver diseases, cardiovascular disease and certain cancers), infectious and mental health diseases. In addition, alcohol frequently strengthens inequalities between and within countries (WHO 2018). Although not as newsworthy today as drug addiction, alcohol is nonetheless a major addiction risk.

Note that measurement of both the prevalence of alcohol consumption and its consequences is fraught with methodological challenges, both regarding approaches used (e.g., surveys and face-to-face interviews) and attribution techniques, especially where multiple contributing factors can apply.

SIZE OF THE PROBLEM

To provide perspective, alcohol consumption represents either the second or third leading global behavioral-related cause of death—more than 7 million annually attributable to smoking, between 2.8 million and 4.0 million to obesity/overweight and 3.0 million to alcohol consumption.[1]

There are generally two health-related aspects of drinking: average amount consumed and alcohol binges. Worldwide in 2016, about 2.3 billion people (43%) age 15 and over were current drinkers, while 3.1 billion (57%) abstained from drinking alcohol over the prior 12 months (WHO 2018). Total alcohol consumption per capita over 15 years of age rose from 5.5 liters of pure alcohol in 2005 to 6.4 liters in 2010, remaining level at 6.4 liters in 2016. Females generally drink less often than males; when women drink, they tend to drink less than men.

On average, current drinkers consume 32.8 grams of alcohol per day, about 20% more (40.0 grams/day) in Africa and 20% less (26.3 grams/day) in South-East Asia. In addition, about one-quarter of all alcohol consumed worldwide is unrecorded—that is, not included in official statistics of taxation or sales, being produced, distributed and sold outside formal governmental control. Worldwide, 44.8% of total recorded alcohol is in the form of spirits, beer (34.3%) and wine (11.7%).

Prevalence of heavy episodic drinking (HED)[2] has decreased globally from 22.6% in 2000 to 18.2% in 2016, but remains high among drinkers, particularly in Eastern Europe and sub-Saharan Africa. Globally, the prevalence of HED peaks at ages 20 to 24.

---

1 The 4.0 million was reported in GBD 2015 Obesity Collaborators (2017); other estimates by WHO.
2 HED is sometimes referred to as binge drinking; definitions can differ (e.g., at least 60 grams of pure alcohol during at least one occasion per month).

U.S. alcohol consumption stayed fairly constant between 2002 and 2016 (51.0% and 51.7%, respectively), decreasing at ages less than 26 and increasing at older ages, as shown in Table 1. Interestingly, prevalence of current and binge alcohol consumption for those younger than 18 was greater for girls than boys.

Table 1
U.S. ADULT DRINKING PREVALENCE

Ages	Current Use		Binge Use 2016	Heavy Use 2016
	2002	2016		
12–13	4.3%	1.3%	0.3%	0.0%
14–15	16.6	7.4	3.7	0.5
16–17	32.6	19.7	10.2	1.7
18–25	60.5	53.3	38.4	10.1
26–34	61.4	65.0	37.2	9.4
35 +	52.1	53.5	21.3	5.2
Total	51.0%	51.7%	24.2%	6.0%
Males	57.4	56.2	28.9	8.3
Females	44.9	47.4	19.8	3.9
Total 12–17	17.6%	9.2%	4.9%	0.8%
Males	17.4	8.8	4.4	0.9
Females	17.9	9.6	5.4	0.6

Source: National Center for Health Statistics. 2018. *Health, United States, 2017: With Special Feature on Mortality*. Table 50. https://www.cdc.gov/nchs/data/hus/hus17.pdf.

Note: Binge drinking: Through 2014, five drinks in a short period at least once in the past month; beginning in 2015, five drinks in a short period for males, four drinks for females. Heavy drinking: Binge drinking at least five times during the past month.

According to two nationally representative surveys of U.S. adults based on face-to-face interviews[3] between 2001–02 and 2012–13, 12-month alcohol use, high-risk drinking (exceeding the daily drinking guidelines in the past 12 months), and DSM-IV AUD[4] increased by 11.2% (from 65.4% to 72.7%), 29.9% (9.7% to 12.6%) and 49.4% (8.5% to 12.7%), respectively. The total annual number of binge drinks consumed per U.S. adult who reported binge drinking increased significantly by 12% from 2011 to 2017 (Kanny et al. 2020). The greatest increases were among females, older adults, racial/ethnic minorities, and those with lower educational attainment and family income—these changes reduced prior differences between categories.

Worldwide, more than a quarter (26.5%) of all 15- to 19-year-olds are current drinkers—about 150 million adolescents (WHO 2018). Based on school surveys, alcohol use often begins before the age of 15 in many countries; among 15-year-olds, prevalence can be between 50% and 70%, with little difference between boys and girls.

In spite of an overall decrease in drinking by high school students in the United States, as shown in Table 2, in 2016 approximately one in three drank alcohol and one in six were binge drinkers. A majority of high school students who drank were binge drinkers (57.8%, having five or more alcoholic drinks in a row on ≥1 day during the previous 30 days) and 43.8% of binge drinkers consumed eight or more drinks in a row (Esser et al. 2017). Between 2006 and 2010, on average 4,300 high schoolers died annually from alcohol-attributed causes.

3 The National Epidemiologic Survey on Alcohol and Related Conditions, with data collected from April 2001 to June 2002, and the National Epidemiologic Survey on Alcohol and Related Conditions III, with data collected from April 2012 to June 2013, in Grant et al. (2017).
4 Alcohol Use Disorder (alcohol abuse and alcohol dependence). DSM is the edition of the Diagnostic and Statistical Manual of Mental Disorders.

Table 2
U.S. 12TH GRADE DRINKING PREVALENCE

Type of Drinking	Gender	1980	1990	2000	2010	2016
Current	All	72.0%	57.1%	50.0%	41.2%	33.2%
	Males	77.4	61.3	54.0	44.2	34.5
	Females	66.8	52.3	46.1	37.9	32.0
Binge	All	41.2	32.2	30.0	23.2	15.5
	Males	52.1	39.1	36.7	28.0	17.2
	Females	30.5	24.4	23.5	18.4	13.5

Source: National Center for Health Statistics. 2018. *Health, United States, 2017: With Special Feature on Mortality*. Table 51.
https://www.cdc.gov/nchs/data/hus/hus17.pdf.

Note: Binge drinking: Through 2014, five drinks in a short period at least once in the past month; beginning in 2015, five drinks in a short period for males, four drinks for females. Heavy drinking: Binge drinking at least five times during the past month.

CONSEQUENCES

The association of drinking a lot of alcohol and excess mortality has been recognized for quite some time. For example, in the Medical Impairment Study of experience between 1909 and 1928 of 39 U.S. life insurers, the mortality ratio for those rated standard was 109% for social drinkers and 115% for those periodically intoxicated, while for those rated substandard was 195% for immoderate use two to 12 times a year, and 331% for immoderate use lasting two or three days, but not oftener than three times a year (Shepherd and Webster 1957).

Although a great deal of public attention is given to mortality due to drunken driving,[5] other health hazards can also be attributed to drinking alcohol in excess. According to WHO (2018), in 2016, alcohol consumption resulted in about 3 million deaths (5.3% of all deaths—7.7% for males and 2.6% for females) worldwide and 132.6 million disability-adjusted life years (5.1% of all DALYs).[6] The proportion of alcohol-attributable deaths decreased somewhat between 2010 (5.6%) and 2016 (5.3%), but the proportion of alcohol-attributable DALYs remained stable (5.1% of all DALYs in 2010 and 2016).
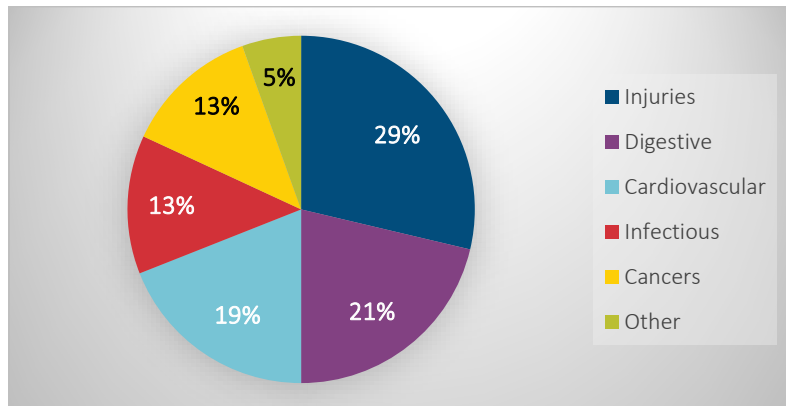
High-risk drinking and alcoholism can cause fetal alcohol spectrum disorders, hypertension, cardiovascular diseases, stroke, liver cirrhosis, several types of cancer and infections, pancreatitis, type 2 diabetes and various injuries (e.g., motor vehicle crashes, violence and property crime). They can be disabling, are associated with numerous psychiatric effects and impaired work and personal productivity, as well as interpersonal dysfunction. They place psychological and financial burdens on society as a whole, as well as the drinkers' families, friends and coworkers.

In 2016, as shown in Figure 1, of all deaths attributable to alcohol consumption, 28.7% were due to injuries, 21.3% to digestive diseases, 19.0% to cardiovascular diseases, 12.9% to infectious diseases and 12.6% to cancers. About 49% of alcohol-attributable DALYs were due to noncommunicable and mental health conditions and 40% were due to injuries. About 13.5% of all deaths of those aged 20–29 years were attributed to alcohol.

---

5 In 2017, almost 11,000 deaths in the United States were due to alcohol-impaired driving, although this represented a 63% reduction from the number of deaths in 1982.
6 In 2016, for males, an estimated 2.3 million deaths and 106.5 million DALYs; for females, 0.7 million deaths and 26.1 million DALYs.

Figure 1

PERCENT OF WORLDWIDE DEATHS BY CAUSE DUE TO DRINKING—2016

Source: World Health Organization (WHO). 2018. Global Status Report on Alcohol and Health 2018.
https://www.who.int/substance_abuse/publications/global_alcohol_report/gsr_2018/en/.

According to the Centers for Disease Control and Prevention,[7] there were about 88,000 average annual deaths attributable to the consumption of alcohol in the United States between 2006 and 2010, with more than half affecting those over age 50. Leading causes were alcoholic liver disease and cirrhosis—24,000; motor vehicle crashes—13,000; and fall injuries, homicides, poisoning and suicides—8,000 each. The relative lack of cardiovascular and cancer deaths attributable to alcohol suggests the estimates in total may be underestimated.

Globally, according to WHO (2018), of the estimated 0.9 million injury deaths attributable to alcohol, about 370,000 deaths were due to road injuries (about half were not drivers), 150,000 to self-harm and 90,000 to interpersonal violence. Of all deaths due to injury, 17.6% has been attributed to alcohol consumption (22.2% for males; 8.3% for females).

An estimated 237 million men and 46 million women have alcohol use disorders, with the highest prevalence among men and women in Europe (14.8% and 3.5%) and the Americas (11.5% and 5.1%). Although, according to WHO (2018), alcohol use disorders are more prevalent in higher-income countries, the alcohol-attributable disease burden is highest in lower-income countries.

the United States, in spite of a general decline in overall mortality, there was a significant increase in age-adjusted mortality due to cirrhosis of the liver between 2009 and 2016 that in turn can cause infections due to peritonitis and sepsis, after being stable over the prior decade (Tapper and Parikh 2018). This was especially the case for young adults and Native Americans. As shown in Table 3, the percentage of age-adjusted mortality rates significantly increased, especially for Native, white and Hispanic Americans.

---

7 Centers for Disease Control and Prevention. 2013. Alcohol Related Disease Impact (ARDI) Application. *http://www.cdc.gov/ARDI*. Accessed March 6, 2020.

Table 3

PERCENT OF TOTAL MORTALITY DUE TO CIRRHOSIS OF THE LIVER—UNITED STATES

Population	Ages	2009	2016
All	25–34	0.9%	1.4%
	35+	1.8%	2.3%
Native Americans	25–34	4.3%	6.3%
	35+	5.8%	7.0%

Data from: Tapper, Elliot B., and Neehar D. Parikh. 2018). Mortality Due to Cirrhosis and Liver Cancer in the United States, 1999–2016: Observational Study. *BMJ* 362:k2817. *https://doi.org/10.1136/bmj.k2817.*

A controversial issue has been whether light or moderate drinking provides a protective effect compared with never drinking. Many earlier studies indicated that moderate levels of alcohol intake were associated with a lower risk of morbidity and mortality than those for nondrinkers. However, several recent studies have challenged this indication. The earlier studies have been criticized because of methodological deficiencies, such as failure to disaggregate the current nondrinking group into lifelong abstainers, former drinkers (who might have quit for health reasons) and occasional drinkers.

Table 4 shows some of the results of a study that linked 13 waves of National Health Interview Surveys (1997 to 2009) to National Death Index records through December 2011 (Xi et al. 2017).[8] The study's objective was to test the association between alcohol consumption and risk of mortality in U.S. adults. The existence of a J-shaped curve in the alcohol-mortality association supports the view that light to moderate drinking may be protective, especially for cardiovascular diseases. In addition, it confirmed that heavy drinking and binge drinking have serious health consequences, including death. Heavy drinking was associated with greater all-cause and cancer mortality risk in males but not females. The protective effects of light and moderate drinking were more pronounced at older ages (ages 60+) than middle ages (40–59), with no significant association in young adults. Although Model 2 (adjusted for several potentially confounding conditions) resulted in somewhat attenuated findings, the basic conclusions continued to hold.

---

8 The study followed 333,247 participants at least 18 years of age with a follow-up period of 8.2 years.

Table 4
HAZARD RATIOS FOR DRINKING HABITS AND MAJOR CAUSES OF DEATH—U.S. ADULTS

| Mortality Cause | Drinking Frequency | | | | | Binge Drinking | | | |
	Lifetime Infrequent	Former	Light	Moderate	Heavy	None	<1 Day/ Month	<1 Day/ Week	≥1 Day/ Week
Model 1									
All-cause	1.19	1.35	0.76	0.74	1.29	0.77	0.86	0.98	1.44
Cancer	1.30	1.61	0.95	1.00	1.86	1.00	0.98	0.99	1.84
Cardiovascular disease	1.23	1.27	0.68	0.62	0.97	0.60	0.94	1.16	1.20
Heart disease	1.24	1.29	0.69	0.62	1.02	0.66	0.93	1.20	1.26
Cerebrovascular disease	1.20	1.21	0.65	0.59	0.77	0.63	1.00	0.94	0.92
Model 2									
All-cause	1.03	1.07	0.79	0.78	1.11	0.80	0.84	0.87	1.13
Cancer	1.03	1.14	0.86	0.87	1.27	0.90	0.81	0.76	1.22
Cardiovascular disease	1.05	0.99	0.74	0.71	0.92	0.73	0.99	1.10	1.03
Heart disease	1.05	0.99	0.75	0.71	0.96	0.77	0.98	1.13	1.07
Cerebrovascular disease	1.08	1.00	0.72	0.68	0.77	0.72	1.06	0.92	0.83

Data from: Xi, Bo, Sreenivas P. Veeranki, Min Zhao, Chuanwei Ma, Yinkun Yan and Jie Mi. 2017. Relationship of Alcohol Consumption to All-Cause, Cardiovascular, and Cancer-Related Mortality in U.S. Adults. *Journal of the American College of Cardiology* 70, no. 8:913–22.

Note: Hazard ratios relate to mortality of lifetime nondrinkers; infrequent: less than 12 drinks over life; light: less than three drinks per week; moderate: less than or equal to 14 drinks per week (males) and seven drinks per week (females); binge: at least five drink in a session. Model 1: Adjusted for sex, age and race/ethnicity. Model 2: Further adjusted for educational attainment, marital status, body mass index, physical activity, smoking and physician-diagnosed diseases (hypertension, heart disease, stroke, cancer and diabetes).

A study of 83 long-term prospective studies in 19 high-income countries[9] found that all-cause mortality had a positive and curvilinear association with alcohol consumption, with the lowest risk being for those consuming below 100 grams per week (Wood et al. 2018). Those who drank between 100 and 200 grams weekly lost between one and two years of life at age 40 compared with those who drank less than 100 grams weekly, while those who drank between 200 and 350 grams weekly lost four to five years of life. In the United Kingdom, men who drank more than 112 grams weekly lost 1.6 years and men who drank more than 196 grams weekly lost 2.7 years, while females who drank more than 112 grams weekly lost 1.3 years. Relativities were similar for men and women, but weaker at older ages. Cardiovascular deaths accounted for about 20% of these losses. There was a J-shaped association for aggregate cardiovascular disease outcomes. Greater alcohol consumption was roughly linearly associated with a higher risk of cardiovascular disease subtypes other than myocardial infarctions. Both those who drank spirits or beer and who binged experienced worse mortality. The findings suggested that current high-risk guidelines for developed countries are too high.

A large study[10] of the relation between alcohol consumption and risk of cardiovascular disease found that moderate alcohol consumption is associated with a lower risk of several, but not all, cardiovascular diseases (Bell et al. 2017). It found an increased risk of coronary heart disease, cardiovascular disease and all-cause mortality in a group of nondrinkers with former and occasional drinkers removed. Compared with moderate drinkers, heavy drinkers had an increased risk of all but coronary heart disease. In most outcomes where a protective effect of moderate drinking

9 Based on Emerging Risk Factors Collaboration (ERFC), EPIC-CVD in the European Prospective Investigation into Cancer and Nutrition (EPIC) prospective cohort study, and the U.K. Biobank study—599,912 current drinkers with an average age of 57 who did not have existing cardiovascular disease, adjusted for known confounders.
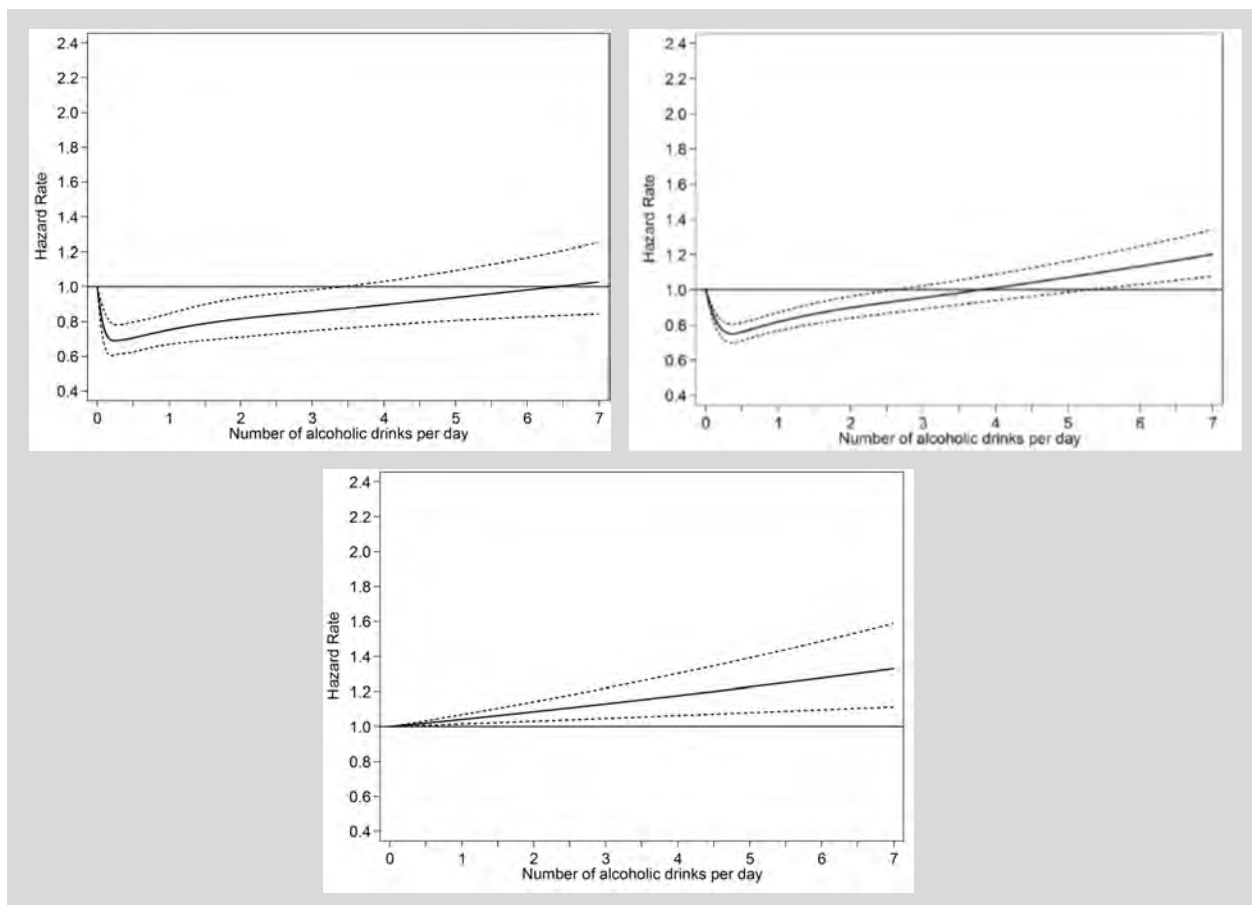10 Clinical research using linked bespoke studies and electronic health records—1.93 million adults without cardiovascular disease at baseline.

was found, the risk was greater in former drinkers, consistent with the "sick quitter" hypothesis, although excess mortality was observed among nondrinkers.

Evidence from short-term alcohol feeding interventions has shown that moderate drinking is related to higher concentrations of high-density lipoprotein cholesterol and adiponectin, with lower concentrations of fibrinogen, but not other cardiovascular characteristics such as triglycerides (Bell et al. 2017).

In a study of about 100,000 U.S. adults, the risk of cancer or death attributable to alcohol consumption was related to average lifetime alcohol consumption (Kunzmann et al. 2018). The results suggest that the risk of some cancers increase with each additional alcoholic drink consumed weekly (Figure 2). However, the combined risk of cancer or death was lowest in light drinkers consuming less than one drink per day, rather than drinkers with no or higher consumption (Table 5). A J-shaped curve applied for all-cause mortality. The results indicate that consumption of between one and five drinks weekly was associated with the lowest combined risk of cancer or death.

Figure 2
ALL-CAUSE, CARDIOVASCULAR-RELATED AND CANCER-RELATED RELATION TO ALCOHOL INTAKE

Source: Kunzmann, Andrew T., Helen G. Coleman, Wen-Yi Huang and Sonja I. Berndt. 2018. The Association of Lifetime Alcohol Use with Mortality and Cancer Risk in Older Adults: A Cohort Study. *PLoS Med* 15, no. 6:e1002585. https://doi.org/10.1371/journal.pmed.1002585.

Note: Reading left to right: all-cause, cardiovascular-related and cancer-related mortality. Hazard ratios compared with mortality of nondrinkers. Adjustments were made for various factors, including gender, race/ethnic group, BMI, smoking, marital status, family history of cancer, energy intake and red meat consumption.

Table 5

HAZARD RATIOS BETWEEN HEAVY AND VERY HEAVY DRINKERS—U.S. ADULTS

Type of Drinker Based on Lifetime Consumption	All-Cause Hazard Ratio			Cancer Risk and Cancer Mortality Hazard Ratio		
	Total	Males	Females	Total	Males	Females
Heavy (2 to less than 3 drinks per day	1.21	1.19	1.38	1.10	1.09	1.13
Very heavy (at least 3 drinks per day)	1.36	1.99	1.42	1.21	1.19	1.46

Source: Kunzmann, Andrew T., Helen G. Coleman, Wen-Yi Huang and Sonja I. Berndt. 2018. The Association of Lifetime Alcohol Use with Mortality and Cancer Risk in Older Adults: A Cohort Study. *PLoS Med* 15, no. 6:e1002585. *https://doi.org/10.1371/journal.pmed.1002585*.

Note: Hazard ratios are compared with moderate drinkers (one to three drinks per week).

PUBLIC POLICY ACTIONS

Many approaches have been taken to discourage the use of alcohol, including (WHO 2018):

- **Maximum permissible blood alcoholic concentration (BAC) while driving.** A majority (97) of countries have a BAC at or below 0.05%, with 37 having a BAC limit of 0.08 and 31 with no limits. Seventy countries (41%) use sobriety checkpoints and random breath-testing as prevention strategies, but 37 (32%) used neither.
- **Price strategies.** The primary strategy, used by almost all countries, is to increase taxes on alcohol.
- **Advertising.** Bans or restrictions on exposure to alcohol advertising across multiple types of media are a common practice. The majority of countries have some type of restriction on beer advertising, with total bans most common for television and radio. Almost half of countries have no restrictions on the use of the internet and social media. Thirty-five countries had no regulation on any type of media.
- **Availability.** The most common legal minimum age limit for purchases is 18 years, followed by 21 and 16 years. Many of those younger than the legal limit obtain alcohol from others, including friends, siblings and parents. Countries without a legal minimum tend to be lower-income countries.
- **Licensing systems.** Forty-seven countries have a licensing system. Others have a government monopoly on at least one level of the alcohol market.
- **Disclosure.** Disclosing the alcohol content on alcoholic beverage labels is required for beer, wine and spirits in a majority of countries.

Alcohol guidelines for acceptable use differ widely by country. For example, in the United States, an upper limit of 196 grams per week is recommended for men and 98 grams per week for women, similar to that in Canada and Sweden. In contrast, guideline limits in Italy, Portugal and Spain are almost 50% higher than these, while U.K. guidelines for men are almost half that of the U.S. guidelines.

CONCLUSION

In conclusion, despite some favorable global trends in prevalence of HED and alcohol-related mortality and morbidity since 2010 and in prevalence of youth drinking in the United States, there has been no progress in reducing total per capita alcohol consumption, with the global burden of disease attributable to alcohol remaining high and even increasing in some countries and for some causes. The recognition and management of high alcohol consumption, especially in binges, remain essential.

Sam Gutterman, FSA, CERA, FCA, FCAS, MAAA, HonFIA, is a consulting actuary, formerly with PriceWaterhouseCoopers in Chicago. He can be reached at *sam.gutterman1@gmail.com*.

REFERENCES

Bell, Steven, Marina Daskaloupou, Eleni Rapsomaniki, Julie George, Annie Britton, Martin Bobak, Juan P. Casas, et al. 2017. Association Between Clinically Recorded Alcohol consumption and Initial Presentation of 12 Cardiovascular Diseases: Population Based Cohort Study Using Linked Health Records. *BMJ* 356:j909. *https://doi.org/10.1136/bmj.j909*.

Esser, Marissa B., Heather Clayton, Zewditu Demissie, Dafna Kanny and Robert D. Brewer. 2017. Current and Binge Drinking Among High School Students—United States, 1991–2015. *Morbidity and Mortality Weekly Report* 66, no. 18. *https://www.cdc.gov/mmwr/volumes/66/wr/mm6618a4.htm*.

GBD 2015 Obesity Collaborators. 2017. Health Effects of Overweight and Obesity in 195 Countries over 25 Years. *New England Journal of Medicine* 377:13–27. *https://www.nejm.org/doi/full/10.1056/NEJMoa1614362*.

Grant, Bridget F., S. Patricia Chou, Tulshi D. Saha, Roger P. Pickering, Bradley T. Kerridge, W. June Ruan, Boji Huang, et al. 2017. Prevalence of 12-Month Alcohol Use, High-Risk Drinking, and DSM-IV Alcohol Use Disorder in the United States, 2001–2002 to 2012–2013: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. JAMA Psychiatry 74, no. 9:911–23. *https://doi.org/10.1001/jamapsychiatry.2017.2161*.

Kanny, Dafna, Timothy S. Naimi, Yong Liu and Robert D. Brewer. 2020. Trends in Total Binge Drinks per Adult Who Reported Binge Drinking—United States, 2011–2017. *Morbidity and Mortality Weekly Report* 69, no. 2. *https://www.cdc.gov/mmwr/volumes/69/wr/mm6902a2.htm*.

Kunzmann, Andrew T., Helen G. Coleman, Wen-Yi Huang and Sonja I. Berndt. 2018. The Association of Lifetime Alcohol Use with Mortality and Cancer Risk in Older Adults: A Cohort Study. *PLoS Med* 15, no. 6:e1002585. *https://doi.org/10.1371/journal.pmed.1002585*.

National Center for Health Statistics (NCHS). 2018. Health, United States, 2017: With Special Feature on Mortality. *https://www.cdc.gov/nchs/data/hus/hus17.pdf*.

Shepherd, Pearce, and Andrew G. Webster. 1957. *Selection of Risks*, 160. Chicago: Society of Actuaries.

Tapper, Elliot B., and Neehar D. Parikh. 2018. Mortality Due to Cirrhosis and Liver Cancer in the United States, 1999–2016: Observational Study. *BMJ* 362:k2817. *https://doi.org/10.1136/bmj.k2817*.

Wood, Angela M., Stephen Kaptoge, Adam S. Butterworth, Peter Willeit, Samantha Warnakula, Thomas Bolton, Ellie Paige and Dirk S. Paul, et al. 2018. Risk Thresholds for Alcohol Consumption: Combined Analysis of Individual-Participant Data for 59,912 Current Drinkers in 83 Prospective Studies. *The Lancet* 391, no. 10129:1513–23.

World Health Organization (WHO). 2018. Global Status Report on Alcohol and Health 2018. *https://www.who.int/substance_abuse/publications/global_alcohol_report/gsr_2018/en/*.

Xi, Bo, Sreenivas P. Veeranki, Min Zhao, Chuanwei Ma, Yinkun Yan and Jie Mi. 2017. Relationship of Alcohol Consumption to All-Cause, Cardiovascular, and Cancer-Related Mortality in U.S. Adults. *Journal of the American College of Cardiology* 70, no. 8:913–22.