



HHS Public Access

Author manuscript

Subst Use Misuse. Author manuscript; available in PMC 2015 December 14.

Published in final edited form as:

Subst Use Misuse. 2014 August ; 49(10): 1250–1258. doi:10.3109/10826084.2014.891620.

Mortality Risks Associated with Average Drinking Level and Episodic Heavy Drinking

CA Schoenborn,

Division of Health Interview Statistics, National Center for Health Statistics, CDC, Hyattsville, Maryland, USA

V. Stommel, and

College of Nursing, Michigan State University, East Lansing, Michigan, USA

B Ward

Division of Health Interview Statistics, National Center for Health Statistics, CDC, Hyattsville, Maryland, USA

Abstract

Data from the 1997–2004 National Health Interview Survey Sample Adult questionnaires were linked to the National Death Index (N=242,397) to examine mortality risks associated with average and episodic heavy drinking. Cox proportional hazard models (Stata 12.0) revealed that (average) heavier drinkers and episodic heavy drinkers (5+ in a day) had increased mortality risks but when examined together, episodic heavy drinking added only modest to the mortality risks of light and moderate drinkers. Limitations and implications of results for survey measurement of potentially harmful levels of alcohol use are noted. This was a Federal study that received no outside funding.

INTRODUCTION

More than half of U.S. adults (115 million) drink alcohol regularly, and another 14% drink occasionally (Schiller *et al.*, 2012). The health effects of alcohol use, both positive and negative, have been the focus of research for decades, with emphasis on alcoholism and alcohol abuse, which are considered clinical psychiatric disorders (APA, 2000; NIAAA, 1995; Warren & Hewitt, 2010). Studies have shown that light to moderate alcohol consumption has positive survival benefits and reduces cardiovascular, stroke, and diabetes risks (Britton *et al.*, 2008; Costanzo *et al.*, 2010; Di Castelnuovo *et al.*, 2006; Muntwyler *et al.*, 1998; Patrat *et al.*, 2010; Vliegenthart *et al.*, 2004). However, problems may arise when individuals exceed moderate levels, either regularly or episodically (Masunaga *et al.*, 2006). High levels of alcohol consumption can lead to a variety of increased health and social problems, including liver and pancreatic disease (Heron, 2007), cancer of the colon, breast, esophagus and mouth (Baan *et al.*, 2007; Fedirko *et al.*, 2011), depression, unintentional injuries, violence, impaired social and occupational functioning, and pregnancy-related

complications, such as fetal alcohol syndrome (Gmel & Rehm, 2003; Rehm *et al.*, 2009; Sokol *et al.*, 2003). Excessive alcohol use ---whether meeting diagnostic criteria for alcoholism or alcohol abuse or not--- is a major public health concern. The U.S. Preventive Services Task Force has recommended screening and behavioral counseling interventions in primary care settings to reduce misuse of alcohol (Guide to Clinical Preventive Services, 2011). Similarly, the National Institute on Alcoholism and Alcohol Abuse (NIAAA) provides clinicians with screening tools for alcohol intervention (NIAAA, 2005). Monitoring misuse of alcohol, also termed “at-risk drinking” in a nationally representative population-based survey presents challenges. Among these challenges is identifying a meaningful threshold between healthy and hazardous drinking levels.

The National Health Interview Survey (NHIS) offers a unique opportunity to explore possible thresholds for defining “at risk drinking” with national survey data because of its large, nationally representative sample and the wide range of information collected on respondent alcohol use and factors associated with both at-risk drinking and health outcomes. Among this information are socio-demographic characteristics such as sex, age, race/ethnicity and education level (Marmot, 2005; Wen *et al.*, 2009; Zajacova & Hummer, 2009), and health-related behaviors such as cigarette smoking (CDC, 2008; Ezzati & Lopez, 2003), physical activity (Schoenborn & Stommel, 2011), as well as body mass index (BMI) (Flegal *et al.*, 2005, 2007; Fontaine *et al.*, 2003). Furthermore, the NHIS can be linked to the National Death Index (NDI) and subsequently offers the opportunity to examine cause-specific mortality in relation to alcohol use as reported in the NHIS.

As part of its annual core questionnaire for adults aged 18 and older, the NHIS incorporates questions about lifetime and current alcohol use, and the number of days that adults had five or more drinks in one day---a measure of episodic heavy drinking. These questions, designed for surveillance of average and “at risk” alcohol use, were added in 1997 following recommendations of experts at NIAAA. The same questions were later recommended by the World Health Organization (WHO) for use in national surveys worldwide (WHO, 2000). More recently, the NIAAA recommendations have been updated to include both average and episodic heavier use together as an indicator of excessive alcohol use (NIAAA, 2005).

The purpose of the current analysis is to determine if levels of alcohol use---as measured in the NHIS---are, in fact, associated with greater mortality among a representative sample of U.S. adults. Our hypotheses were that: (1) heavier drinkers, defined as having consumed an average of >14 drinks per week for men and >7 drinks per week for women (USDA and DHHS, 2011), would have higher mortality risks than adults who drank lesser amounts; (2) current drinkers who engaged in episodic heavy drinking (5+ drinks in a day) would have higher mortality risks than drinkers who did not engage in this behavior; and (3) that the elevated mortality risks associated with episodic heavy drinking would differ for drinkers with varying levels of average consumption, such that the increased hazards would be greater for moderate drinkers than for heavier drinkers—whose average consumption was already substantial.

METHODS

Study Population

The NHIS is a household-based survey of approximately 40,000 households throughout the United States conducted continuously since 1957 and released annually. Some information is collected on all household members. One civilian adult in each family (the “Sample Adult”) is randomly selected to answer additional questions about his/her own health, including alcohol use. In the current analysis, data from the 1997–2004 NHIS Sample Adult Core questionnaires were merged in order to examine up to 10-year mortality outcomes associated with alcohol use during the year prior to the NHIS interview. These NHIS data were the most recent available with linkage to the National Death Index (NDI), a centralized database at the National Center for Health Statistics (NCHS) containing information on all deaths occurring in the 50 states and the District of Columbia. NDI record linkage for the NHIS has been completed for deaths occurring through December 31, 2006. Of the NHIS Sample Adult interviews completed during the study period, 242,397 (93.9%) were designated as “eligible for linkage,” with sufficient interview information for linking with NDI records. Of these, 140,741 adults were current drinkers at the time of interview and provided complete data for both average drinking level and episodes of heavy drinking. Details of the NCHS linking methodology are described elsewhere (NCHS, 2009). During the follow-up period from January 1, 1997 through December 31, 2006, 17,139 deaths were identified among the NHIS sample adults eligible for linkage. Of these, 6,391 deaths occurred among adults who were current drinkers at the time of interview. The analysis was limited to deaths occurring 2 years after the interview (n=4,675) to diminish the likelihood that reduced drinking levels at the time of interview reflected approaching death. Respondents not identified in the death records were presumed to be alive as of December 31, 2006 using restricted access data files that contain exact interview date and exact death date. The time scale was number of months between date of interview and death or censoring. Final (unconditional) annual NHIS response rates over the 8-year period ranged from 86.1% to 90.3% for the Family component (taking into account Household non-response) and from 69.6% to 74.3% for the Sample Adult component (taking into account Household and Family non-response). The Sample Adult response rates, conditional upon household participation, ranged from 74.2% to 82.4%. Analysis was conducted in 2013.

Measures

Alcohol consumption—NHIS questions address both lifetime and current alcohol consumption. Adults are asked if they ever had 12+ drinks in any one year and, if not, whether they had 12+ drinks in their entire life. Adults who had had 12+ drinks in their lifetime were asked about their drinking in the past year using two questions: “In the past year, how often did you drink any type of alcoholic beverage?” and “In the past year, on those days you drank alcoholic beverages, on the average, how many drinks did you have?” Those adults who had 1+ drinks in the past year were defined as current drinkers (n=140,741). Current drinkers are the focus of this analysis. Current drinking status was estimated by first converting average drinking frequency (reported in times per week, month or year) to total days drank during the year. This total was then multiplied by average number of drinks on days the person drank to compute total annual alcohol consumption.

Finally, total annual consumption was divided by 52 to estimate average weekly consumption. Current drinkers were classified as: infrequent/light (< 3 drinks per week), moderate (3–7 drinks per week, women; 3–14 drinks per week, men), and heavier (>7 drinks per week, women; >14 drinks per week, men). For this analysis, infrequent drinkers (< 12 drinks in past year) were included in the category with light drinkers after determination that the mortality hazards for the two groups are similar.

Episodic heavy drinking was assessed using the NHIS question: “In the past year, on how many DAYS did you have 5 or more drinks of any alcoholic beverage?” This question, asked of all current drinkers, was designed to capture information about drinking patterns not available from the measure of average drinking behavior. This indicator, however, it is not a measure of “binge drinking,” generally defined as 5+ drinks (sometimes 4+ for women) on a single drinking *occasion* or in a 2-hour period (CDC, 2012). Multiple thresholds for number of days of episodic heavy drinking were examined: 1+ days; 3+ days; 12+ days; and 52+ days. For the Cox models in table 2, episodic heavy drinking was classified as having had 5+ drinks in one day 3+ days in the past year. The cutoff point of 3+ days was chosen so as to exclude rare occasions of episodic heavy drinking associated with exceptional social/family celebrations such as weddings, etc. while retaining sufficient sample size for meaningful statistical interpretation.

Mortality indicators—Using 1997–2004 NHIS-NDI linked mortality datasets, the following four underlying causes of death were examined: all causes, alcohol-related cancers (including breast, esophagus, larynx, liver, mouth/tongue/lip, pharynx, and colon), liver disease, and cardiovascular disease.

Covariates—Each model includes: sex, age, race/ethnicity, education level, cigarette smoking status, aerobic leisure-time physical activity (Carlson *et al.*, 2010), and BMI. All variables are self-reported. Age is recorded in single years was used as a continuous variable in the models. The race/ethnicity classification consists of adults of Hispanic origin (regardless of race) and five non-Hispanic race groups: white (ref), black, American Indian/Alaska Native, Asian/Native Hawaiian or Other Pacific Islander, and multiple races. Highest educational attainment is categorized as: Less than high school graduation, General Equivalency Diploma (GED), high school graduate (ref), some college, bachelor’s degree, graduate degree (Master’s degree or higher). Cigarette smoking status consists of current smokers (adults who had smoked at least 100 cigarettes in their lifetime and were smoking either every day or some days at the time of interview) (ref), former smokers and never smokers (adults who had never smoked as many as 100 cigarettes in their lifetime). The aerobic leisure-time physical activity indicator is consistent with the 2008 Federal Physical Activity Guidelines which specify adults should engage in at least 150 minutes per week of at least moderate intensity aerobic physical activity. The categories used in the model were: no aerobic activity (ref), some activity but less than 150 minutes per week, and 150 minutes per week of moderate intensity activity or 75 minutes of vigorous activity or an equivalent combination. Body mass index ($\text{kg}/\text{meters}^2$) is computed from self-reported height and weight, and then adjusted for known reporting bias described elsewhere (Stommel and

Schoenborn, 2009). The quadratic term for both age and BMI were included in the model to account for their non-linear relationship with mortality.

Statistical Analysis

This analysis focuses on the mortality risks associated with average levels of drinking as well as episodes of heavy drinking, with the latter comparing persons who had 3+ days during a year on which they consumed 5+ drinks in one day to persons who had fewer or no such days. Models with alternative cut-points were also examined. The analysis was conducted with Stata (version 12) software (StataCorp, 2011). The NHIS employs a complex, multistage sample design with clustering into primary sampling units (counties), stratification, and oversampling of specific population subgroups to obtain a probability sample of U.S. households. The final person-level weights are adjusted according to a quarterly post-stratification by sex, race/ethnicity and age classes using population estimates produced by the U.S. Bureau of the Census (Botman et al, 2000). The survey design information is captured in three variables, indicating the PSUs, strata and weights, with the latter being divided by 8 to obtain averaged population weights for the 8 combined annual surveys. This information has been incorporated in all analyses to obtain correct variance estimates and standard errors. Cox Proportional Hazards models, using the 'svy' prefix appropriate for complex survey design, were employed to estimate individual survival time to death or censoring date. Hazard ratios and 95% confidence intervals are reported for all-cause and cause-specific mortality for adults with various levels of alcohol use. Estimates for all analyses were weighted using post-stratification to adjust for missing cases due to eligibility status (NCHS, 2010). The proportional hazard assumption was assessed graphically comparing observed to predicted (based on the models) KM survival curves and the curves were parallel. Nested models were compared using the Wald test, since the log-likelihood test is not fully applicable with complex survey data.

RESULTS

During the period of 1997–2004, among all U.S. adults about 23% were lifetime abstainers, 8.5% were lifetime infrequent drinkers, and 7% were former drinkers. More than 60% of all adults were classified as current drinkers, including 43% who were infrequent/light drinkers, 14% moderate drinkers, and 5% heavier drinkers.

Table 1 shows that among current drinkers in the U.S. resident population, almost 70% were infrequent/light drinkers, while 22.6% engaged in moderate and 7.5% in heavier drinking. Episodes of 5+ drinks a day increase precipitously with higher average alcohol consumption: 11.2 % of infrequent/light drinkers, 48.3% of moderate drinkers, and 75.3% of heavier drinkers had at least three days with 5+ drinks during the year prior to the interview. Whereas almost 80% of infrequent/light drinkers had no days with 5+ drinks in the past year, only 20% of heavier drinkers had no such days; over half of heavier drinkers had 52+ days of episodic heavy drinking. Comparison of mean and median number of days of episodic heavy drinking similarly shows that it is only among heavier drinkers that 5+ drinks a day is a common occurrence (median=52 days per year).

Table 2 shows the unweighted counts and the weighted percentages of deaths that occurred at least two years after the NHIS interview, by average and episodic heavy drinking status. The distribution of deaths by average drinking reveals that deaths from all causes to infrequent/light (63%), moderate (25%) and heavier (12%) drinkers were disproportionate to their distribution in the population. Of the almost 4,700 deaths occurring to current drinkers over the study period, only 311 were attributed to alcohol-related cancers, 91 to liver-related diseases, and 1,535 to cardiovascular disease. Results were similar when looking at episodic heavy drinking.

Mortality Risks among Current Drinkers

Preliminary analyses using unadjusted models—that is, models containing only average drinking and episodic heavy drinking variables (data not shown) --- suggested that heavier drinking posed increased mortality risks for each cause of death studied, but having 5+ drinks in one day at least three times during the year substantially reduced risk in most instances (the one exception was liver deaths). However, given substantial age differences in this drinking behavior (younger adults are significantly more likely to engage in episodic heavy drinking than older adults; Schoenborn *et al.*, 2013), the counterintuitive results of the unadjusted models make sense. After adjusting for age, the mortality risks associated with episodic heavy drinking are substantially increased. This pattern persists for overall mortality risks as well as liver-related mortality, even after further adjustment for smoking status. Since smoking is positively correlated with heavy episodic drinking, controlling for smoking reduces the mortality risk that can be directly attributed to episodic heavy drinking. A similar, but weaker, confounding effect is associated with educational achievement: better educated individuals are both less likely to engage in episodic heavy drinking and have more favorable mortality profiles. Thus, controlling for education reduces the mortality risk attributable to episodic heavy drinking. Still, age is the dominant confounding variable: young people are more likely to engage in episodic heavy drinking *and* have lower mortality risks. Thus, after controlling for all the covariates, the adjusted models (Table 3) reveal increased mortality risks for individuals engaged in episodic heavy drinking.

Specifically, Table 3 shows four models with mortality hazard ratios (HRs) associated drinking practices at the time of the NHIS interview for infrequent/light, moderate, and heavier current drinkers. All models control for: sex, age, race, education, cigarette smoking, leisure-time physical activity, and BMI. Model 1 examines the main effects of current average drinking level with infrequent/light drinkers as the reference category. This model does not include episodic heavy drinking (that is, having had 5+ drinks on at least three days.) No increased mortality risk is found among moderate drinkers relative to infrequent/light drinkers. However, heavier drinkers face higher risks of mortality from all causes (HR=1.44, $p<0.001$), all alcohol-related cancers (HR=1.79, $p<0.01$), and liver-related causes (HR=6.17, $p<0.001$) but not from cardiovascular disease. Model 2 examines the main effect of episodic heavy drinking--- having at least 3 days annually with 5+ drinks--- on mortality risks without taking average drinking levels into account. The results show that having had at least 3 days with 5+ drinks in the past year increased risks for all-cause mortality (HR=1.22, $p<0.001$), liver-related causes (HR=3.52, $p<0.001$), and deaths due to cardiovascular disease (HR=1.22, $p<0.05$), but not for alcohol-related cancers.

Both average drinking level and episodic heavy drinking are included in Model 3 as independent predictors. In this model, heavier drinkers remain at increased mortality risk from all causes (HR=1.34, $p<0.001$), alcohol-related cancers (HR=1.84, $p<0.05$), and liver-related causes (HR=3.30, $p<0.05$). As in Model 1, there was no increased risk for cardiovascular deaths associated with being a heavier drinker. Likewise, moderate drinkers had no increased risk relative to infrequent/light drinkers for any of the four causes of death examined. However, with at least 3 episodes of heavy drinking, there were modestly increased risks of all-cause mortality (HR=1.12, $p<0.05$) and cardiovascular mortality risk (HR=1.24, $p<0.05$), but no additional risks for alcohol-related cancers or liver-related causes independent of average alcohol consumption.

The final model (Model 4) shows the interactions between average drinking levels and episodic heavy drinking. Only one such interaction, with liver-related death as the outcome risk, was statistically significant ($p<0.012$). The hazard ratios for Model 4 focus on the contrasts between persons who reported 3+ days of episodic heavy drinking versus those who reported fewer such days, within the three average drinking levels of infrequent/light, moderate, and heavier. Only two such contrasts were statistically significant: infrequent/light (HR=3.88, $p<0.05$) and moderate (HR=3.39, $p<0.05$) current drinkers, who had occasional bouts of episodic heavy drinking have higher risks of dying from liver-related diseases than persons with similar overall alcohol consumption who never or rarely engage in this behavior. By contrast, heavier drinkers did not suffer from an additional risk of liver death due to episodic heavy drinking. None of the other interaction models and contrasts involving episodic heavy drinking shows significant effects. Replication of Model 4 with varying thresholds (Table 4) yielded similar results for each cause of death studied, with one exception: among infrequent/light and moderate drinkers the contrasts between those who engaged in episodic heavy (5+ in a day) drinking 52+ days during the year versus those who had fewer such days was no longer significant. This should not be surprising, since only very few people who are moderate or light drinkers engage in episodic heavy drinking (see Table 1) resulting in a contrast of low statistical power. Furthermore, the contrast compares persons engaging in episodic heavy drinking for 52+ days to persons engaging in this behavior for less than 52 days which means that some members of the comparison group already have many episodic heavy drinking days. Thus, whatever damage heavy episodic drinking does has already occurred at a lower threshold.

DISCUSSION

In this paper, we sought to assess if average levels of alcohol consumption and episodic heavy drinking (5+ drinks in one day) ---separately and combined---were associated with greater mortality among a representative sample of U.S. adults. As hypothesized, across each of the causes of death studied, except cardiovascular disease, heavier drinkers were at increased mortality risk relative to infrequent/light drinkers, while moderate drinkers showed no increased risk. Our measure of episodic heavy drinking (at least three days annually on which a person drinks 5+ drinks), predicts mortality risks but only for liver disease and only among infrequent/light and moderate drinkers. Apparently, even a few episodic heavy drinking days can have an adverse impact on liver disease and consequent

mortality. Drinkers who engage in episodic heavy drinking are at increased risk for cardiovascular death, even though average heavy drinking does not increase such risks.

The results presented here offer support for our hypothesis 1— heavier drinkers, as defined here, are at greater risk of death than infrequent/light drinkers. While we found support for hypothesis 2— drinkers who engage in episodic heavy drinking at least three days in a year are at increased risk for cardiovascular and overall mortality— this finding is an average effect regardless of average (infrequent/light, moderate, heavier) drinking level. When examining the effects of episodic heavy drinking among each of the three classes of average drinking patterns (infrequent/light, moderate and heavier), we found support for hypothesis 3 but only for liver disease mortality: episodic heavy drinking increases the risk of dying from liver disease for infrequent/light and moderate drinkers and not for heavier drinkers. The 5+ drinks information in itself adds modestly to our prediction of mortality risks associated with alcohol use beyond that obtained by knowing average use.

The current analysis is subject to a number of limitations. Some respondents may have been unwilling to report socially unacceptable levels of heavy drinking (Stone *et al.*, 2000; Paulhus, 2002; Stockwell *et al.*, 2004), leading to a downward bias in risk estimates associated with heavy drinking. Second, the recall period for the alcohol questions refers to a full year prior to the interview, which may cause difficulties for respondents trying to report on both the frequency and amount of alcohol consumed during such a long period. Finally, drinking patterns established for the year prior to interview could have changed over the maximum 10-year mortality follow-up period. The fact that our results show quite modest associations between episodic heavy drinking and mortality (regardless of the threshold used (that is, 1+ days, 3+ days, 12+ days, or 52+ days) may be less a reflection of the true dangers of episodic heavy drinking and more a reflection of the limits of cross-sectional interviews for assessing episodic or infrequent health behaviors.

CONCLUSIONS

Alcohol consumption reported in the NHIS predicts both all-cause and cause-specific mortality in the hypothesized direction. The widely reported associations between current drinking behavior and mortality were confirmed: adults who consume heavier amounts of alcohol, but not those who consumed moderate amounts, experience greater mortality risks for all causes combined, and for alcohol-related cancers and liver disease compared with infrequent/light drinkers. Episodic heavy drinking behavior increases mortality risks for all causes, and for liver-related and cardiovascular causes, independent of average drinking; and when used in combination with usual alcohol consumption, information on episodic heavy drinking provides some additional explanatory power for risk of liver disease mortality.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

References

- American Psychological Association (APA). Diagnostic and statistical manual of mental disorders (DSM-IV-TR). 4. Washington, DC: American Psychological Association; 2000. text revised
- Baan R, Straif K, Grosse Y, Secretan B, El Ghissassi F, Bouvard V, Altieri A, Coglianò V. WHO International Agency for Research on Cancer Monograph Working Group. Carcinogenicity of alcoholic beverages. *Lancet Oncology*. 2007; 8:292–293. [PubMed: 17431955]
- Botman SL, Moore TF, Moriarity CL, Parsons VL. Design and estimation for the National Health Interview Survey, 1995–2004. National Center for Health Statistics. *Vital Health Stat*. 2000; 2(130)
- Britton A, Marmot MG, Shipley M. Who benefits most from the cardioprotective properties of alcohol consumption – health freaks or couch potatoes? *Journal of Epidemiology and Community Health*. 2008; 62:905–908. [PubMed: 18791048]
- Carlson SA, Fulton JE, Schoenborn CA, Loustalot F. Trend and prevalence estimates based on the 2008 physical activity guidelines for Americans. *American Journal of Preventive Medicine*. 2010; 39:305–313. [PubMed: 20837280]
- Centers for Disease Control and Prevention (CDC). Smoking-attributable mortality, years of potential life lost, and productivity losses – United States, 2000–2004. *Morbidity and Mortality Weekly Report*. 2008; 57:1226–1228. [PubMed: 19008791]
- Centers for Disease Control and Prevention (CDC). Vital signs: Binge drinking prevalence, frequency, and intensity among adults – United States, 2010. *Morbidity and Mortality Weekly Report*. 2012; 61:14–19. [PubMed: 22237031]
- Costanzo S, Di Castelnuovo A, Donati MB, Iacoviello L, de Gaetano G. Alcohol consumption and mortality in patients with cardiovascular disease: A meta-analysis. *Journal of the American College of Cardiology*. 2010; 55:1339–1347. [PubMed: 20338495]
- Di Castelnuovo A, Costanzo S, Bagnardi V, Donati MB, Iacoviello L, de Gaetano G. Alcohol dosing and total mortality in men and women: An updated meta-analysis of 34 prospective studies. *Archives of Internal Medicine*. 2006; 166:2437–2445. [PubMed: 17159008]
- Ezzati M, Lopez AD. Estimates of global mortality attributable to smoking in 2000. *Lancet*. 2003; 362:847–852. [PubMed: 13678970]
- Fedirko V, Tramacere I, Bagnardi V, Rota M, Scotti L, Islami F, Negri E, Straif K, Romieu I, La Vecchia C, Boffetta P, Jenab M. Alcohol drinking and colorectal cancer risk: An overall and dose-response meta-analysis of published studies. *Annals of Oncology*. 2011; 22:1958–1972. [PubMed: 21307158]
- Flegal KM, Graubard BL, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. *JAMA*. 2005; 293:1861–1867. [PubMed: 15840860]
- Flegal KM, Graubard BL, Williamson DF, Gail MH. Cause-specific excess deaths associated with underweight, overweight, and obesity. *JAMA*. 2007; 298:2028–2037. [PubMed: 17986696]
- Fontaine KR, Redden DT, Wang C, Westfall AO, Allison DB. Years of life lost due to obesity. *JAMA*. 2003; 289:187–193. [PubMed: 12517229]
- Gmel G, Rehm J. Harmful alcohol use. *Alcohol Research & Health*. 2003; 27:52–62. [PubMed: 15301400]
- Guide to Clinical Preventive Services, 2012: Recommendations of the U.S. Preventive Services Task Force. Washington, DC: Agency for Healthcare Research and Quality; 2011. Retrieved July 17, 2013, from: <http://www.ahrq.gov/professionals/clinicians-providers/guidelines-recommendations/guide/index.html>
- Heron MP. Deaths: Leading causes for 2004. National Vital Statistics Reports. 2007; 56:1–95. [PubMed: 18092547]
- Kopper LL, Dekker JM, Hendriks HF, Bouter LM, Heine RJ. Moderate alcohol consumption lowers the risk of type 2 diabetes: A meta-analysis of prospective observational studies. *Diabetes Care*. 2005; 28:719–725. [PubMed: 15735217]
- Marmot, M. *The Status Syndrome: How Social Standing Affects Our Health and Longevity*. New York: Times Books; 2005.

- Masunaga N, Kimura A, Miyataka M, Nishioka N, Hirano Y, Hayashi T, Ishikawa K. Effects of alcohol consumption on cardiovascular events in male patients with healed myocardial infarction. *Circulation Journal*. 2006; 70:1263–1268. [PubMed: 16998256]
- Muntwyler J, Hennekens CH, Buring JE, Gaziano JM. Mortality and light to moderate alcohol consumption after myocardial infarction. *Lancet*. 1998; 352:1882–1885. [PubMed: 9863785]
- National Center for Health Statistics (NCHS). The National Health Interview Survey (1986–2004) linked mortality files, Mortality Follow-up through 2006: Matching Methodology. Hyattsville: National Center for Health Statistics; 2009.
- National Center for Health Statistics (NCHS). National Health Interview Survey (1986–2004) Linked Mortality Files: Analytic Guidelines. Vol. 2010. Hyattsville: National Center for Health Statistics; 2010. Retrieved July 17, 2013, from: http://www.cdc.gov/nchs/data/datalinkage/nhis_mort_analytic_guidelines.pdf
- National Institute on Alcohol Abuse and Alcoholism (NIAAA). Diagnostic criteria for alcohol abuse and dependence; Alcohol Alert. 1995. p. 30 Retrieved July 17, 2013, from: <http://pubs.niaaa.nih.gov/publications/aa30.htm>
- National Institute on Alcohol Abuse and Alcoholism. A pocket guide for alcohol screening and brief intervention. Rockville: National Institute on Alcohol Abuse and Alcoholism; 2005. <http://pubs.niaaa.nih.gov/publications/Practitioner/PocketGuide/pocket.pdf>
- Patra J, Taylor B, Irving H, Roerecke M, Baliunas D, Mohapatra S, Rehm J. Alcohol consumption and the risk of morbidity and mortality for different stroke types – a systematic review and meta-analysis. *BMC Public Health*. 2010; 10:258. Retrieved July 17, 2013, from: <http://www.biomedcentral.com/1471-2458/10/258>. [PubMed: 20482788]
- Paulhus, DL. Socially desirable responding: The evolution of a construct. In: Brown, H.; Jackson, DN.; Wiley, DE., editors. *The Role of Constructs in Psychological and Educational Measurement*. Mahwah: Lawrence Erlbaum Associates; 2002.
- Rehm J, Mathers C, Popova S, Thavorncharoensap M, Teerawattananon Y, Patra J. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. *Lancet*. 2009; 373:2223–2233. [PubMed: 19560604]
- Schiller JS, Lucas JW, Ward BW, Peregoy JA. Summary health statistics for U.S. adults: National Health Interview Survey, 2010. *Vital and Health Statistics*. 2012; 10:1–207.
- Schoenborn CA, Adams PF, Peregoy J. Health behaviors of adults: United States, 2008–2010. *Vital and Health Statistics*. 2013; 10:1–173. [PubMed: 25116426]
- Schoenborn CA, Stommel M. Adherence to the 2008 adult physical activity guidelines and mortality risk. *American Journal of Preventive Medicine*. 2011; 40:514–521. [PubMed: 21496750]
- Sokol RJ, Delaney-Black V, Nordstrom B. Fetal alcohol spectrum disorder. *JAMA*. 2003; 290:2996–2999. [PubMed: 14665662]
- StataCorp. *Stata Statistical Software: Release 12*. College Station: StataCorp LP; 2011.
- Stockwell T, Donath S, Cooper-Stanbury M, Chikritzhs T, Catalano P, Mateo C. Under-reporting of alcohol consumption in household surveys: A comparison of quantity–frequency, graduated–frequency and recent recall. *Addiction*. 2004; 99:1024–1033. [PubMed: 15265099]
- Stommel M, Schoenborn CA. Accuracy and usefulness of BMI measures based on self-reported weight and height: Findings from the NHANES & NHIS 2001–2006. *BMC Public Health*. 2009; 9:421. Retrieved July 17, 2013, from: <http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2784464/>. [PubMed: 19922675]
- Stone, AA.; Turkkan, JS.; Bachrach, CA.; Jobe, JB.; Kurtzman, HS.; Cain, VS., editors. *The Science of Self-report: Implications for Research and Practice*. Mahwah: Lawrence Erlbaum Associates; 2000.
- United States Department of Agriculture (USDA) and United States Department of Health and Human Services (DHHS). 2010 Dietary Guidelines for Americans. Washington, DC: U.S. Government Printing Office; 2011. Retrieved July 17, 2013, from: <http://www.health.gov/dietaryguidelines/2010.asp>
- Vliegenthart R, Oei HHS, van den Elzan APM, van Rooij FJA, Hofman A, Oudkerk M, Witteman JCM. Alcohol consumption and coronary calcification in a general population. *Archives of Internal Medicine*. 2004; 164:2355–2360. [PubMed: 15557415]

- Warren KR, Hewitt BG. NIAAA: Advancing alcohol research for 40 years. *Alcohol Research & Health*. 2010; 33:5–17. [PubMed: 23579932]
- Wen CP, Cheng TYD, Tsai SP, Chan HT, Hsu HL, Hsu CC, Eriksen MP. Are Asians at greater mortality risks for being overweight than Caucasians? Redefining obesity for Asians. *Public Health Nutrition*. 2009; 12:497–506. [PubMed: 18547457]
- World Health Organization (WHO). *International Guide for Monitoring Alcohol Consumption and Related Harm*. Geneva: Department of Mental Health and Substance Dependence, Noncommunicable Diseases and Mental Health Cluster; 2000.
- Zajacova A, Hummer RA. Gender differences in education effects on all-cause mortality for white and black adults in the United States. *Social Science & Medicine*. 2009; 69:529–537. [PubMed: 19589633]

Population, weighted percent distributions, number of days of episodic heavy drinking among U.S. adults ^a

TABLE 1

	Population ^b	(%)	Days had 5+ drinks on a given day in past year					No. days in past year had 5+ drinks in one day		
			Never	1–2	3–11	12–51	52+	Total	Mean	Median
Current drinking level										
Infrequent/light drinker	80,724	(69.9)	79.7	9.0	7.1	3.3	0.8	100.0	1.7	0
Moderate drinker	25,978	(22.6)	43.9	7.8	16.2	16.3	15.8	100.0	17.9	2
Heavier drinker	8,608	(7.5)	20.7	3.9	9.4	14.0	51.9	100.0	96.1	52
Total	114,860	(100.0)	67.2	8.4	9.4	7.1	8.0	100.0	.	.

^aData source: National Health Interview Survey, 1997–2004 linked to mortality records through December 31, 2006.

^bPopulation in 1,000s. Weighted population estimates (average annual) exclude persons who did not drink in the past 12 months and those with unknown current drinking status and/or unknown 5+ drinking days in past year.

Unweighted counts and weighted percentages of all-cause and cause-specific mortality by average and episodic heavy drinking status

Table 2

		Causes of death											
All causes		Alcohol-related cancers ^a			Liver-related			Cardiovascular			Other causes		
N	%	N	%	N	%	N	%	N	%	N	%	N	%
Current average drinking													
Infrequent/light	2,967	62.8	200	4.2	29	0.7	1,046	20.4	1,692	37.5			
Moderate	1,139	25.3	71	1.6	24	0.4	345	7.5	699	15.8			
Heavier	569	11.9	40	0.9	38	0.8	144	3.0	347	7.1			
Total ^b	4,675	100.0	311	6.7	91	2.0	1,535	30.9	2,738	60.4			
Episodic heavy drinking													
< 3 days of 5+ drinks	3,862	82.5	251	5.5	40	0.9	1,321	26.5	2,250	49.6			
3+ days of 5+ drinks	807	17.5	56	1.2	53	1.0	221	4.7	477	10.6			
Total ^b	4,669	100.0	307	6.7	93	1.9	1,542	31.2	2,727	60.2			

Data source: National Health Interview Survey, 1997–2004, linked to mortality records through December 31, 2006. Average and episodic drinking in year preceding the interview. Deaths occurring at least two years after interview.

^aIncludes alcohol-related cancers (oral, esophageal, liver, larynx, breast, and colon cancer).

^bTotals for the two alcohol variables differ due to different numbers of unknowns. Numbers may not add to totals due to rounding.

TABLE 3

Hazard Ratios (95% CI) predicting all-cause and cause-specific mortality based on average and episodic heavy drinking ^a

	Causes of death			
	All causes	Alcohol-related cancers ^b	Liver-related	Cardiovascular
Model 1: Current average drinking				
Infrequent/Light (ref.)	1.00	1.00	1.00	1.00
Moderate	0.97 (0.89, 1.05)	1.05 (0.75, 1.46)	1.58 (0.81, 3.11)	0.88 (0.76, 1.02)
Heavier	1.44 (1.29, 1.61)***	1.79 (1.20, 2.67)**	6.17 (3.08, 12.36)***	1.23 (0.99, 1.53)
Model 2: Episodic heavy drinking				
< 3 days of 5+ drinks (ref.)	1.00	1.00	1.00	1.00
3+ days of 5+ drinks	1.22 (1.10, 1.34)***	1.16 (0.80, 1.68)	3.52 (1.87, 6.63)***	1.22 (1.01, 1.48)*
Model 3: Current average drinking & episodic heavy drinking (main effects only)				
Infrequent/Light (ref.)	1.00	1.00	1.00	1.00
Moderate	0.94 (0.87, 1.03)	1.07 (0.76, 1.50)	1.13 (0.56, 2.31)	0.87 (0.75, 1.01)
Heavier	1.34 (1.17, 1.53)***	1.84 (1.14, 2.96)*	3.30 (1.29, 8.44)*	1.07 (0.84, 1.38)
< 3 days of 5+ drinks (ref.)	1.00	1.00	1.00	1.00
3+ days of 5+ drinks	1.12 (1.00, 1.26)*	0.94 (0.61, 1.43)	2.15 (0.90, 5.14)	1.24 (1.00, 1.53)*
Model 4: Current average drinking & episodic heavy drinking (interaction effects)				
3+ days of 5+ drinks vs. < 3 days of 5+ drinks among:				
Infrequent/Light (ref.)	1.14 (0.94, 1.38)	0.66 (0.32, 1.36)	3.88 (1.36, 11.06)*	1.15 (0.79, 1.67)
Moderate	1.14 (0.96, 1.35)	0.94 (0.50, 1.77)	3.39 (1.27, 9.06)*	1.26 (0.93, 1.69)
Heavier	1.06 (0.85, 1.33)	1.22 (0.50, 3.08)	0.75 (0.28, 2.04)	1.34 (0.86, 2.07)

^aData source: National Health Interview Survey, 1997–2004, linked to mortality records through December 31, 2006. Average and episodic drinking in year preceding the interview. Covariates: sex, age, education, race/ethnicity, smoking, physical activity, BMI. CI is Confidence Interval.

^bIncludes alcohol-related cancers (oral, esophageal, liver, larynx, breast, and colon cancer).

* p<0.05;

** p<0.01;

*** p<0.001

TABLE 4

Hazard Ratios (95% CI) predicting mortality based average and episodic heavy drinking at various thresholds
^a

No. days with 5+ drinks & average drinking level ^b	Causes of death			
	All causes	Alcohol-related cancers ^c	Liver-related	Cardiovascular
1+ days with 5+ drinks				
Infrequent/Light	1.15 (0.99, 1.33)	0.94 (0.50, 1.76)	3.22 (1.23, 8.43)*	1.24 (0.96, 1.62)
Moderate	1.12 (0.95, 1.32)	1.37 (0.75, 2.49)	2.98 (1.09, 8.13)*	1.14 (0.85, 1.51)
Heavier	1.05 (0.83, 1.31)	1.56 (0.64, 3.82)	0.78 (0.27, 2.26)	1.27 (0.82, 1.98)
3+ days with 5+ drinks				
Infrequent/Light	1.14 (0.94, 1.38)	0.66 (0.32, 1.36)	3.88 (1.36, 11.06)*	1.15 (0.79, 1.67)
Moderate	1.14 (0.96, 1.35)	0.94 (0.50, 1.77)	3.39 (1.27, 9.06)*	1.26 (0.93, 1.69)
Heavier	1.06 (0.85, 1.33)	1.22 (0.50, 3.08)	0.75 (0.28, 2.04)	1.34 (0.86, 2.07)
12+ days with 5+ drinks				
Infrequent/Light	1.10 (0.85, 1.43)	0.61 (0.22, 1.72)	4.38 (1.54, 12.42)*	1.00 (0.58, 1.74)
Moderate	1.09 (0.90, 1.33)	1.31 (0.67, 2.57)	3.93 (1.44, 10.73)*	1.12 (0.79, 1.59)
Heavier	1.05 (0.85, 1.31)	1.12 (0.49, 2.57)	0.89 (0.35, 2.26)	0.99 (0.65, 1.50)
52+ days with 5+ drinks				
Infrequent/Light	0.84 (0.50, 1.43)	0.47 (0.10, 3.39)	1.98 (0.26, 14.96)	0.97 (0.34, 2.71)
Moderate	1.22 (0.97, 1.54)	1.22 (0.49, 3.03)	1.65 (0.56, 4.85)	1.32 (0.86, 2.02)
Heavier	1.20 (0.97, 1.49)	1.57 (0.70, 3.49)	1.34 (0.55, 3.28)	0.96 (0.64, 1.43)

^aData source: National Health Interview Survey, 1997–2004, linked to mortality records through December 31, 2006. Average and episodic drinking in year preceding the interview. Covariates: sex, age, education, race/ethnicity, smoking, physical activity, BMI. CI is Confidence Interval.

^bHRs reflect hazards associated with various thresholds of days with 5+ drinks in one day in past year compared with those who have not engaged in these amounts of episodic heavy drinking behavior for drinkers at each level of average consumption. Hazard ratios for 3+ days with 5+ drinks (shaded) are identical to those shown in Model 4 of table 3 and repeated here for ease of comparison.

^cIncludes alcohol-related cancers (oral, esophageal, liver, larynx, breast, and colon cancer).

* p<0.05;

** p<0.01;

*** p<0.001