

Published in final edited form as:

Drug Alcohol Depend. 2008 May 1; 95(1-2): 62–72.

A Prospective Study of Risk Drinking: At Risk for What?

Deborah A. Dawson^a, Ting-Kai Li^b, and Bridget F. Grant^a

^a *Laboratory of Epidemiology and Biometry, Division of Clinical and Biological Research, National Institute on Alcohol Abuse and Alcoholism, Bethesda, Maryland, USA*

^b *Office of the Director, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, Bethesda, Maryland, USA*

Abstract

Data from two waves of a nationally representative U.S. population sample were used to link frequency of risk drinking in the year preceding the Wave 1 interview with the incidence or occurrence of various adverse outcomes in the approximately 3-year period between the two interviews ($n = 22,245$ Wave 1 drinkers who were reinterviewed at Wave 2). Risk drinking was defined as consuming the equivalent of 5+ standard drinks in a day for men and the equivalent of 4+ standard drinks in a day for women. Controls included sociodemographic and health characteristics, mean quantity of drinks consumed on risk drinking days and average volume of intake on non-risk drinking days. The odds of nonhierarchical alcohol abuse and dependence, initiation of smoking and incidence of nicotine dependence were increased at all frequencies of risk drinking and showed a fairly continuous increase in magnitude with increasing frequency, reaching OR of 3.03 – 7.23 for daily/near daily risk drinking. The incidence of liver disease was strongly increased among weekly or more frequent risk drinkers (OR = 2.78 – 4.76). The odds of social harm, drug use and drug dependence were increased among daily/near daily risk drinkers (OR = 1.61 – 2.63), and the likelihood of marital disruption and drivers license revocation showed near-significant increases at all frequencies of risk drinking. Frequency of risk drinking interacted with volume of intake on non-risk drinking days in predicting alcohol abuse and illicit drug use and with duration of drinking in predicting alcohol dependence. Risk drinking poses a threat of many types of harm, both directly and indirectly through its association with smoking initiation and nicotine dependence. These findings have illustrative value for prevention programs, and they indicate that frequent risk drinker is a strong marker for alcoholism.

Keywords

risk drinking; prospective risk

Please send all correspondence to: Deborah A. Dawson, Ph.D. NIAAA/LEB, Room 3071, 5635 Fishers Lane, MSC9304, Bethesda, MD 20892-9304, Telephone: 301-435-2255, Fax: 301-435-2255, E-Mail: ddawson@mail.nih.gov.

The views and opinions expressed in this paper are those of the authors and should not be construed to represent the views of any of the sponsoring organizations, agencies or the U.S. government.

The study on which this paper is based, the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), is sponsored by the National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health, U.S. Department of Health and Human Services, with supplemental support from the National Institute on Drug Abuse.

Publisher's Disclaimer: This is a PDF file of an unedited manuscript that has been accepted for publication. As a service to our customers we are providing this early version of the manuscript. The manuscript will undergo copyediting, typesetting, and review of the resulting proof before it is published in its final citable form. Please note that during the production process errors may be discovered which could affect the content, and all legal disclaimers that apply to the journal pertain.

1.0 INTRODUCTION

Although volume of ethanol intake remains the predominant measure of alcohol consumption in epidemiological research, it is widely acknowledged that average daily intake may not accurately reflect risks associated with variable drinking patterns, e.g., when heavy weekend drinking combined with low intake on weekdays results in a moderate level of average consumption. Accordingly, many recent studies have attempted to link more informative aspects of drinking pattern with mortality, morbidity, injury, and social harm. The aspect of drinking pattern most commonly addressed is frequency of risk drinking, i.e. heavy per-occasion drinking. Sometimes referred to as heavy episodic drinking or binge drinking, both of these terms may be misleading, as risk drinking can be chronic rather than episodic, and binge drinking can extend over many days, as is observed in clinical populations. Risk drinking has been defined in many ways, but the most widely-used definition is the consumption of five or more (5+) drinks on a single occasion or day, often modified to five or more drinks for men and four or more drinks for women (5+/4+). U.S. surveys typically ask about drinks consumed per day rather than per occasion, both because of the conceptual difficulty of determining when one occasion ends and another begins and because daytime drinking, e.g., at lunch, is rare in the United States, see Dawson et al., 1995; Dawson and Room, 1995. Other definitions have employed higher thresholds (e.g., 8+ drinks), limits on the duration of the drinking occasion (e.g., within a period of no more than two hours for binge drinking), and substitution of more subjective measures (e.g., frequency of intoxication).

Cross-sectional studies have provided ample evidence that risk drinking is positively associated with various types of harm, including alcohol use disorders and their symptoms (Bradley et al., 2001; Dawson et al., 2005; O'Connell et al., 2006), liver disease (Bradley et al., 2001), intentional self-harm (Rossow et al., 2006), injuries (Bradley et al., 2001; Brown et al., 2006; Cherpitel et al., 1995; O'Connell et al., 2006; Wechsler et al., 1994, 2001), other substance use (Bradley et al., 2001), risky sexual behavior and sexual victimization (Bradley et al., 2001; Buddie and Testa, 2005; Wechsler et al., 1994, 2001), impaired mental and physical health, cognitive ability and ability to perform activities of daily living (Cairney et al., 2007; Moore et al., 2003; Okoro et al., Okosun et al., 2005; 2004; Stranges et al., 2006; Tremblay et al., 2003), obesity and overweight (Arif and Rohrer, 2005) and school problems (Rehm et al., 2005; Wechsler et al., 1994, 2001). Emergency department studies have provided additional evidence of the in-the-event risk of injury associated with risk drinking (e.g., Cherpitel et al., 2006). In a recent study of Lithuanian deaths between 1988 and 1997, the increased rates of mortality from accidents, violence and alcohol-poisoning on weekends, when alcohol consumption is heaviest, provided another type of evidence supportive of a positive association between risk drinking and harm (Chenet et al., 2001).

Although these studies reveal strong patterns of association, their cross-sectional design precludes inferences as to causality. However, there is also a growing body of research investigating the impact of risk drinking on the prospective risk of harm, and the results of these studies have been mixed. In a 15-year follow-up of U.S. adults aged 18–30 years at baseline, Pletcher et al. (2004) found that the prevalence of early coronary calcification increased with frequency of drinking 5+ drinks at baseline (OR = 1.7 for any versus no 5+ consumption in the past 30 days), and the association remained near-significant ($p = .059$) even after adjusting for volume of consumption. Jarvenpaa et al. (2005) reported that consuming 5 + drinks at least once a month tripled the risk of dementia in a study of Finnish twins followed for 25 years. In an 8-year follow-up of Canadian adults 18–64 years of age, Murray et al. (2002) found that having ever consumed 8+ drinks in a single day during the year preceding baseline was associated with increased risks of coronary heart disease and hypertension among men and of coronary heart disease among women. Oesterle et al. (2004) reported that adolescents who engaged in chronic heavy drinking had increased risks of overweight, obesity

and high blood pressure at age 24. In contrast, Steffens et al. (2006) failed to find an association between risk drinking (5+/4+) at baseline and incidence of hypertension in a sample of adults followed for an average of 5.6 years, and Haynes et al. (2005) reported no association between baseline risk drinking and the incidence of anxiety and depression.

In terms of mortality, several population cohort studies have found an increased risk of deaths from external causes among individuals whose usual quantity of drinks consumed was indicative of a chronic or frequent risk drinking pattern (Laatikainen et al., 2003; Malyutina et al., 2002; Paljarvi et al., 2005). Dawson (2001) reported an increased risk among individuals whose usual intake was 5+ drinks but who drank less than once a month. The study of Finnish men by Laatikainen et al. (2003) also found an increased risk of death from all causes and from ischemic heart disease among those with heavy (6+) drinking occasions, and these increases persisted after adjustment for average volume of intake. Makela et al. (2005) reported a 34% increase in the risk of all-cause mortality in association with a high volume of alcohol consumed on heavy-drinking occasions. In a study of patients hospitalized with a myocardial infarction and followed for an average of 3.8 years, individuals who had consumed 3+ drinks of any specific alcoholic beverage type in a 1–2 hour period during the year preceding hospitalization were twice as likely as other drinkers to have died (Mukamal et al., 2005). Both Rehm et al. (2001) and Tolstrup et al. (2004) reported that at a given volume of consumption, the prospective risk of all-cause mortality was greatest for individuals whose drinking pattern was indicative of more drinks on fewer occasions, but these differences fell short of statistical significance. Similarly, a prospective study of Dutch adults 45–74 years of age found an increase in all-cause mortality among frequent heavy drinkers that failed to attain statistical significance (San Jose et al., 1999). A time-series analysis of Canadian deaths between 1977 and 1996 found no association between deaths from injuries and the proportion of adults who consumed 5+ drinks at least once a year (Mann et al., 2001). An analysis of alcohol-related mortality in the United States based on etiological fractions reported that heavy episodic drinking accounted for 52.4% of the alcohol-attributable deaths among males and 45.8% of those among females (Rivara et al., 2004).

In summary, there are a number of studies showing a positive association between risk drinking and harm, but the results are difficult to synthesize for a number of reasons. First, many of the studies are cross-sectional in design, precluding causal inferences. Of those that are prospective, few have examined outcomes other than mortality. Second, definitions of risk drinking have varied substantially across studies, with many analyses based on dichotomous measures that do not permit assessment of a “dose-response” effect with respect to frequency. Third, there has been wide variation in the extent to which potential confounders, including other aspects of drinking, are controlled. Finally, prospective studies have differed in terms of the nature of the cohorts (general population versus patient samples, for example) and length of follow-up. These factors make it impossible to compare the magnitudes of associations for different types of harm across studies and may contribute to some of the inconsistent findings that have been noted.

This study was designed to obviate some of these limitations, providing comparative estimates of the prospective associations between frequency of risk drinking and a broad range of harms, including initiation of substance use; incidence of substance use disorders, other psychiatric disorders and chronic diseases; and occurrence of social problems ranging from drivers license revocation to spouse abuse. The data were derived from two waves of a longitudinal study of a representative sample of U.S. adults, the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), with a follow-up interval of approximately three years between interviews. A continuous measure of frequency of risk drinking at baseline permitted assessment of the nature of the risk curves for the various harms, e.g., linear (dose-response) versus threshold, and the large sample size of the NESARC allowed adjustment for a wide

array of potential confounders. The analysis employed sequential models with varying levels of control in order to illustrate the role of these confounders in attenuating the associations between frequency of risk drinking and harm, and interactions between frequency of risk drinking and other consumption measures were assessed.

2.0 METHODS

2.1 Sample

The data for this analysis came from Waves 1 and 2 of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC), designed by the National Institute on Alcohol Abuse and Alcoholism. The 2001–2002 Wave 1 NESARC sample consisted of 43,093 U.S. adults 18 years of age and older, representing the population residing in households and noninstitutional group quarters in all 50 states and the District of Columbia. Data were collected in personal interviews conducted by interviewers trained by the U.S. Bureau of the Census (response rate = 81.0%), and the survey spanned alcohol use and alcohol use disorders, tobacco and drug use and disorders, mood, anxiety and personality disorders, and general health.

In Wave 2, interviewers attempted to reinterview all eligible respondents from Wave 1, i.e., all those who had not died, become incapacitated or institutionalized, left the country or entered the military ($n = 39,959$ eligibles). The reinterview rate among these eligibles was 86.9%, yielding a Wave 2 sample of 34,653 U.S. adults and a cumulative response rate over the two surveys of 70.2%. Sample weights for Wave 2 respondents were calculated so as to ensure that the weighted Wave 2 sample represents survivors of the original sample who remained in the noninstitutionalized U.S. population. New topics included post-traumatic stress disorder, attention-deficit hyperactivity disorder, and personality disorders not included in Wave 1. The Wave 2 questionnaire also included questions on various types of discrimination, acculturation, domestic violence, childhood abuse, sexual orientation, and changes in sociodemographic indicators. This analysis is based on a subsample of the NESARC respondents who had consumed at least one drink in the year immediately preceding the Wave 1 interview ($n = 26,946$, of whom 22,245 were reinterviewed in Wave 2 and included in this analysis).

2.2 Primary exposure variable: Frequency of risk drinking

Using the thresholds for risk drinking recommended in *Helping Patients with Alcohol Problems: A Health Practitioner's Guide* (NIAAA, 2004), men's frequency of risk drinking was estimated as the largest of: a) the frequency of drinking five or more (5+) alcoholic drinks in a single day and b) the frequencies of drinking ≥ 2.7 ounces (≥ 4.5 standard drinks) of ethanol in a single day of coolers, beer, wine or spirits, where beverage-specific ounces of ethanol intake per day were calculated based on number of drinks, size of drink, and ethanol content of main brand consumed. Women's frequency of risk drinking was estimated as the largest of: a) the frequency of drinking four or more (4+) alcoholic drinks in a single day and b) the frequencies of drinking ≥ 2.1 ounces (≥ 3.5 standard drinks) of ethanol in a single day of coolers, beer, wine or spirits. All frequencies reflect number of risk drinking days in the year preceding the Wave 1 interview, ascertained using categorical response categories.

2.3 Outcome Measures

2.3.1 Incidence of DSM-IV alcohol abuse and dependence—Using the Alcohol Use Disorders and Associated Disabilities Interview Schedule - DSM-IV Version (AUDADIS-IV, Grant et al., 2001), alcohol use disorders were defined for two periods between the Wave 1 and Wave 2 interviews: 1) the past year, i.e., the year preceding the Wave 2 interview, and 2) the approximately two-year period since the Wave 1 interview but prior to the past year. In accordance with the DSM-IV criteria (American Psychiatric Association, 1994), to be classified with alcohol dependence during either of these time periods, respondents had to

report one or more symptoms of at least three of the seven DSM-IV dependence criteria. For the period since the Wave 1 interview but prior to the past year, they further had to report that some of these symptoms occurred within the same one-year period. To be classified with abuse, respondents had to report the occurrence of at least one symptom of any of the four DSM-IV abuse criteria. The classification of abuse was nonhierarchical; that is, it did not rule out a prior or concurrent dependence classification. Individuals were counted as positive for incidence of alcohol abuse and dependence if they met the criteria for these disorders for the first time in either of the two previously-defined time periods between the Wave 1 and Wave 2 interviews. The proportions of at-risk baseline drinkers with incident abuse and dependence over the follow-up interval were 4.9% ($n = 1,221$) and 3.8% ($n = 957$), respectively.

2.3.2 Incidence of substance use and other substance use disorders—

Respondents were counted as incident for illicit drug use (3.7%) if they had not used any illicit drugs prior to the Wave 1 interview but reported illicit use of any of the following between the Wave 1 and Wave 2 interviews: sedatives, tranquilizers, painkillers, stimulants, marijuana, cocaine/crack, hallucinogens, inhalants/solvents, heroin or other illicit drugs. Likewise, they were counted as incident for smoking (2.1%) if they had not used any type of tobacco prior to Wave 1 but reported use of cigarettes, cigars, pipe tobacco, snuff or chewing tobacco between Wave 1 and Wave 2. Drug abuse and dependence and nicotine dependence were classified using algorithms similar to those described above for alcohol use disorders. Individuals with no prior drug abuse diagnosis were counted as incident for drug abuse (1.9%) if they experienced the incidence of abuse for any of the ten individual drug types between the Wave 1 and Wave 2 interview, and those with no prior drug dependence were counted as incident for drug dependence (1.0%) if they experienced the incidence of dependence for any of the ten individual drug types. They were counted as incident for nicotine dependence (6.1%) if they met the criteria for this disorder for the first time between the Wave 1 and Wave 2 interview.

2.3.3 Incidence of mood, anxiety and medical disorders—The derivation of the NESARC mood and anxiety disorders has been described in detail elsewhere (Grant et al., 2004, 2005). To be counted as incident for any mood disorder (7.2%), respondents with no history of independent major depressive episode, dysthymia, mania or hypomania at Wave 1 must have met the criteria for at least one of those conditions between the Wave 1 and Wave 2 interviews. To be counted as incident for any anxiety disorder (7.2%), respondents with no history of independent panic disorder (with or without agoraphobia), specific or social phobia or generalized anxiety disorder at Wave 1 must have met the criteria for at least one of those conditions between the Wave 1 and Wave 2 interviews. (Independent disorders rule out those that are exclusively illness-induced or substance-induced, and independent major depressive episode also rules out conditions attributed to bereavement.) To be incident for a medical condition, respondents had to report that the condition had been diagnosed by a doctor at Wave 2 but not at Wave 1. Any coronary heart disease (CHD) reflects angina, tachycardia, myocardial infarction and “other heart disease”; any liver disease reflects cirrhosis and “other liver disease”; and any gastric disorder reflects stomach ulcer and gastritis. The proportions of baseline drinkers who were incident for these diseases varied from 0.6% for any liver disease to 8.5% for hypertension.

2.3.4 Other outcome measures—Occurrence of the following outcomes did not require that they happened for the first time, only that they occurred between the Wave 1 and Wave 2 interviews: divorce/separation, including termination of cohabiting (4.7%), neglect of school or work responsibilities (5.9%), violent behavior comprising bullying, forcing someone to have sex, fighting, harassment, or intentionally causing physical injury (2.8%), driver’s license revocation (3.6%) and spouse abuse comprising pushing/shoving, hitting, threatening with weapon, cutting/bruising, spousal rape, or causing serious injury (4.9%).

2.4 Covariates

2.4.1 Alcohol consumption measures—In the previously cited literature, studies that controlled for aspects of consumption other than frequency of risk drinking typically adjusted for overall volume of ethanol intake. Although this is reasonable if risk drinking is dichotomized as any versus none, overall volume is not an appropriate control when testing associations with frequency of risk drinking, because chronic risk drinking is the equivalent of high-volume drinking. In order to include controls that were more independent of frequency of risk drinking, we opted in this study to control for the average volume of intake on non-risk drinking days and the mean quantity of drinks consumed on risk drinking days. The latter, coupled with the frequency of risk drinking, yields the volume consumed on risk drinking days. These measures thus account for the overall volume of consumption without clouding the interpretation of the OR for different frequencies of risk drinking. Duration of drinking, another important potential confounder, was measured by subtracting the age when the respondent first started drinking (excluding small tastes or sips) from the age at the baseline Wave 1 interview.

2.4.2 Other potential confounders—Numerous covariates were considered as potential confounders of the association between frequency of risk drinking and the outcomes described above. These were all measured for the year preceding the Wave 1 interview and included: 1) basic demographics (age, sex and race/ethnicity -- Black and Hispanic versus all others); 2) measures associated with socioeconomic status and health (married, attended/completed college, family income, employed, body mass index and self-perceived health status (excellent/very good/good versus fair/poor); 3) measures of substance use and psychiatric disorders (family history of alcoholism, tobacco and illicit drug use, any mood or anxiety disorder, any personality disorder); and 4) other measures of alcohol consumption (volume of ethanol consumed on non-risk drinking days and mean quantity of alcohol consumed on risk drinking days).

2.5 Analysis

Adjusted odds ratios expressing the association between frequency of risk drinking and the incidence/occurrence of the outcome measures were estimated in multiple logistic regression models using SUDAAN (Research Triangle Institute, 2001), a software package that uses Taylor series linearization to adjust variance estimates for complex survey designs. All analyses other than the occurrence of social harms were restricted to the populations at risk of the outcome in question. Thus, models predicting incidence of specific disorders excluded individuals who had already experienced the incidence of those disorders prior to the baseline interview. Models for aggregate outcomes excluded individuals with prior history related to any of the component substances/disorders. For example, models for the incidence of any drug use excluded individuals who had ever used any of the 10 illicit drugs queried in the NESARC prior to baseline, and models predicting the incidence of any mood disorder excluded those who had ever had any prior mood disorder, etc. The same approach was applied to the other aggregate psychiatric and medical outcomes. The models for divorce/separation and spouse abuse were restricted to individuals who were married or cohabiting at the Wave 1 interview.

3.0 RESULTS

As indicated in Table 1, 59.9% of baseline drinkers never engaged in risk drinking in the year preceding the Wave 1 interview. Another 16.7% engaged in risk drinking less than once a month, about 9% each did so 1–3 times a month and 1–2 times a week, and about 3% each did so 3–4 times a week or on a near daily or daily basis. Risk drinkers were younger, less likely to be married, more likely to be male and more likely to be employed than those who never engaged in risk drinking (hereafter also referred to as non-risk drinkers). Those who reported risk drinking at least once a week were less likely than non-risk drinkers and occasional risk

drinkers to be non-Hispanic whites and to have attended or completed college, and their incomes were lower, on average. Smoking, illicit drug use, and mood, anxiety and personality disorders were consistently least common among non-risk drinkers and most common among daily/near daily risk drinkers. The proportion of drinkers in fair/poor health declined steadily from 10.3% of non-risk drinkers to 7.6% of those who reported risk drinking 1–3 times a month, then increasing steadily to 20.6% of daily/near daily risk drinkers. Overweight and obesity also demonstrated a u-shaped pattern with respect to frequency of risk drinking.

Average daily volume (ADV) of ethanol intake increased sharply with frequency of risk drinking and was nearly 40 times as great among daily/near daily risk drinkers as among non-risk drinkers. ADV consumed on non-risk drinking days initially increased with frequency of risk drinking and subsequently decreased as more frequent risk drinking days apparently replaced non-risk drinking days. There was also a significant increase in the quantity of ethanol consumed per risk drinking occasion as frequency of risk drinking increased. Thus the most frequent risk drinkers not only engaged in risk drinking more often but also consumed more alcohol on those risk drinking days than did those who engaged in risk drinking less frequently. Duration of drinking showed a u-shaped pattern with respect to frequency of risk drinking that was consistent with the pattern with respect to age at baseline but suggestive of an earlier age at first drink among the daily/near daily risk drinkers.

The fully-adjusted OR for incidence of alcohol abuse and dependence were significantly increased at all frequencies of risk drinking (see Figure 1 and Table 2), showing a pattern of steady increase up through frequencies of 3–4 times a week, after which the OR for abuse decreased slightly while the OR for dependence continued to increase. The odds of these disorders were increased significantly even among those engaged in risk drinking less than once a month and were quadrupled or more among those engaging in risk drinking more three times a week or more often. Daily/near daily risk drinkers were more than seven times as likely to have developed alcohol dependence as individuals who had not engaged in risk drinking. The odds of initiating illicit drug use were significantly increased among individuals who engaged in risk drinking once a week or more often (OR = 1.63 – 1.87), and the odds of incident illicit drug dependence, but not abuse, were increased among daily/near daily risk drinkers (OR = 2.22), with irregular evidence of increase at slightly lower frequencies of risk drinking. The OR for both initiating tobacco use and incidence of nicotine dependence showed a consistently significant positive linear relationship with frequency of risk drinking (OR = 1.51 to 4.67 and 1.32 to 3.03, respectively).

After adjustment for all covariates, frequency of risk drinking was not associated with incidence of mood or anxiety disorders, arteriosclerosis, hypertension, CHD, gastric disorder or arthritis. However, the odds of incident liver disease were increased among individuals who engaged in risk drinking once or twice a week (OR = 2.78) or daily/near daily (OR = 4.76).

The odds of divorce/separation showed a steady and consistent increase with frequency of risk drinking (OR = 1.36 – 2.63), although some of the OR had confidence intervals whose lower limits were slightly lower than 1.00, i.e., they fell just short of statistical significance.

Daily/near daily risk drinking was significantly associated with an increased risk of violence (OR = 1.61) and spouse abuse (OR = 2.06) and had an association with neglect of school/work responsibilities that approached significance (OR = 1.39, 95% CI = 0.97 – 1.98). The likelihood of having had a driver's license revoked showed a consistently significant, linear increase with frequency of risk drinking, with OR of 1.28 to 2.11 (significant at weekly or greater frequencies).

Table 3 examines the impact of successive levels of adjustment on the associations between daily/near daily risk drinking and the outcomes examined in this paper. Most of the statistically

significant unadjusted ORs retained their significance through all levels of adjustment. However, the associations of daily/near daily risk drinking frequency with incidence of any drug abuse and neglect of school or work responsibilities were significant (OR = 2.06 and 1.71, respectively) prior to including controls for other consumption measures, and the associations with any mood disorder, any anxiety disorder, hypertension, and any CHD were statistically significant (OR = 1.43 – 1.86) prior to including controls for socioeconomic status, health and BMI.

As shown in Table 4, prior to adjusting for substance use and comorbid conditions there were statistically significant associations between risk drinking once or twice a week and the occurrence of divorce/separation, neglect of school/work responsibilities, violent behavior and spouse abuse. After controls for these measures were added, these associations lost significance and decreased in magnitude, as well – particularly neglect of school and work and violent behavior. The OR for incidence of drug abuse lost significance after adding controls for other aspects of consumption. Also noteworthy is the fact that apparent protective associations between risk drinking once or twice a week and incidence of arteriosclerosis, hypertension, any CHD, any gastric disease and arthritis immediately disappeared after introduction of controls for age, sex and race/ethnicity. Similar patterns of change in magnitude and in loss of statistical significance were observed in the OR for less frequent risk drinking (data not shown).

Tests for interactions between frequency of risk drinking and the other two consumption measures revealed only three outcomes for which there were consistent interactions across all frequencies of risk drinking (data not shown). There were negative interactions with volume of non-risk consumption for incidence of alcohol abuse ($p = .011$) and initiation of illicit drug use ($p = .030$) and a positive interaction with duration of dependence for incidence of dependence.

4.0 DISCUSSION

Using longitudinal data from a nationally representative sample of U.S. adults, this study adds to a growing body of research demonstrating that risk drinking – consuming the equivalent of 5+ alcoholic drinks in a day for men or 4+ alcoholic drinks in a day for women – is associated with a prospective risk of many types of harm. In this study, these increases in risk were independent of demographic and socioeconomic characteristics of the risk drinkers, as well as of their general health, tobacco and illicit drug use, psychiatric conditions, and other aspects of their overall alcohol intake. Comparisons across a broad range of harms, made possible by the unique scope of the NESARC database, revealed that risks were greatest for alcohol use disorders (AUDs), smoking and nicotine dependence, and liver disease. Variation in the shape of risk curves and the extent to which there were interactions between frequency of risk drinking and other aspects of alcohol consumption indicate the complexity of interpreting the prospective harms associated with risk drinking.

4.1 Alcohol use disorders

Even at frequencies of less than once a month, baseline risk drinking was associated with a significant increase in the incidence of alcohol abuse and dependence, and the OR for incidence of alcohol dependence rose steadily with increasing frequency of risk drinking. For the incidence of alcohol abuse, though, the OR did not continue to rise at risk drinking frequencies greater than 3–4 times a week. Because most drinking in the U.S. takes place on weekends (Dawson et al., 1995), the category of 3–4 times a week can be considered to be the first category that includes weekday risk drinking. It is possible that *any* weekday risk drinking, irrespective of frequency, may be sufficient for endorsement of symptoms for some abuse criteria, e.g., repeated neglect of school or work responsibilities. It should be noted that the leveling off of the risk curve for abuse does *not* reflect the likelihood of a dependence diagnosis

overriding an abuse diagnosis at daily/near daily frequencies of risk drinking. Abuse was not defined as secondary to dependence in this analysis; that is, it does not reflect “abuse only.” Rather, individuals were allowed to be incident for abuse even if preceded or accompanied by dependence.

The negative interaction between frequency of risk drinking and volume of non-risk consumption for the incidence of alcohol abuse indicates that frequency of risk drinking takes on less importance among individuals who have a high volume of non-risk consumption. This suggests that 5+/4+ may be too high a threshold for increasing the risks of alcohol abuse, i.e., that the risks may be increased even at lower quantities of intake if the pattern of intake is regular enough. For example, the 0.08g/dl blood alcohol concentration (BAC) criterion for impaired driving that has been passed in all states may have led individuals to endorse the abuse symptom of driving after having had too much to drink even at levels of intake lower than 5+/4+ drinks. The positive interaction between frequency of risk drinking and duration of drinking may simply mean that risk drinking is more of a marker for alcoholism when it represents a sustained pattern of drinking; however, this cannot be determined with certainty because duration of drinking reflects all drinking, and not necessarily drinking at risk levels. Alternatively, given that age was controlled, this interaction may reflect a greater liability for the incidence of dependence among individuals who started drinking at earlier ages. Such an interpretation would be consistent with many studies that have found a positive association between early initiation of drinking and lifetime prevalence of alcohol dependence (DeWit et al., 2000; Grant and Dawson, 1997; Grant et al., 2001; Hingson et al., 2006).

4.2 Other substance use and substance use disorders

Frequency of risk drinking was more strongly associated with initiation of smoking and incidence of nicotine dependence (significant positive OR even for infrequent risk drinking) than with initiation of illicit drug use and incidence of illicit drug use disorders (OR significant only at weekly or greater frequencies, and not for drug abuse). These differences may reflect the fact that tobacco is more easily obtained than illicit drugs. The strong associations between risk drinking and smoking/nicotine dependence are supported by numerous cross sectional studies as well as by studies investigating specific causal mechanisms (see reviews in Funk et al., 2006; Little, 2000).

As was true for alcohol abuse, there was a negative interaction between frequency of risk drinking and volume of non-risk consumption in predicting the initiation of illicit drug use. Again, this suggests that the risk of drug use may be increased even at lower quantities of intake, if the pattern of intake is regular enough. That is, regular drinking occasions, regardless of the quantity of alcohol consumed on those occasions, may provide exposure to illicit drugs and increase the possibility initiation drug use.

4.3 Mood and anxiety disorders

There was virtually no association between frequency of risk drinking and the adjusted prospective risks of Axis I conditions other than substance use disorders. However, prior to adjusting for SES, BMI and general health, there was a significantly increased likelihood of developing mood and anxiety disorders among daily/near daily risk drinkers. This suggests that this partially adjusted association may have been the spurious result of daily/near daily risk drinkers being at increased risk of developing mood and anxiety disorders because of their poorer health and lower incomes.

4.4 Chronic medical conditions/organ damage

For the outcome of liver disease, the increase in incidence at weekly or greater frequencies of risk drinking can directly attributed to the organ damage caused by exposure to large doses of

ethanol. Given the positive association between frequency of risk drinking and quantity consumed on risk drinking occasions, the fairly linear risk curve for frequency of risk drinking and incidence of liver disease implies a more exponential risk curve with respect to volume of intake. This is consistent with the findings of a prospective study that examined the associations between volume of ethanol intake and the risks of developing alcoholic cirrhosis and alcoholic liver disease (Becker et al., 1996).

There was no association between frequency of risk drinking and the adjusted prospective risks of chronic medical conditions other than liver disease in the fully adjusted models. Prior to adjusting for SES, BMI and health, there was a significantly increased likelihood of developing hypertension and CHD among daily/near daily risk drinkers. As was the case for mood and anxiety disorders, this suggests a spurious association deriving from their relatively high rates of fair/poor health, overweight and obesity.

4.5 Psychosocial harm

The risk of psychosocial harm was most pronounced among chronic heavy drinkers, although the odds of marital disruption and drivers license revocation were increased and near significant at all frequencies of risk drinking. At all frequencies of risk drinking, the odds ratios for divorce/separation and drivers license revocation were higher than those for neglect of school/work responsibilities, violent behavior and spouse abuse. This suggests that a higher quantity of drinks, i.e., a quantity in excess of the 5+/4+ limits typically used to define risk drinking, may be required to trigger these latter outcomes. That is, they might be more sensitive to and strongly associated with frequency of drinking 8+ or 12+ drinks than to the current frequency of 5+/4+ risk drinking measure.

4.6 Attributable risk

For most types of harm, the prospective risks were by far the greatest for daily/near daily risk drinkers, indicating that the individual-level harm associated with risk drinking is greater for chronic heavy drinking, i.e., high-volume drinking, than for episodic heavy drinking. From a population or prevention perspective, though, it is worth noting that the larger proportions of occasional than chronic risk drinkers mean that the attributable risks associated with episodic heavy drinking may nearly equal, or even exceed, those associated with chronic heavy drinking (Rose, 1985; Edwards et al., 1994). The adjusted population attributable risk can be estimated as $AR = p(ARR-1)/p(ARR-1)+1$, where p is the proportion of drinkers with a given frequency of risk drinking and ARR is the adjusted relative risk associated with that frequency (Kahn, 1983). In this analysis, because all incidence rates were less than 10%, with most lower than 5%, the ARR can be reasonably approximated by the adjusted OR from the multiple logistic regression models (http://www.ats.ucla.edu/STAT/SAS/faq/relative_risk.htm; see also Zhang and Yu, 1998). Thus, to use the incidence of alcohol abuse as an example, the attributable risk associated with engaging in risk drinking 1–3 times a month, $(.091 \times (2.46-1))/(.091 \times (2.46-1) + 1) = .117$, actually exceeds the attributable risk associated with engaging in risk drinking on a daily or near daily basis, $(.030 \times (3.93-1))/(.030 \times (3.93-1) + 1) = .081$. From a public health point of view, therefore, it is evident that even occasional risk drinking may be responsible for substantial personal, social and economic costs and that treatment and intervention efforts aimed at frequent risk drinkers must be accompanied by more global prevention efforts that target the behavior of engaging in risk drinking within the general population.

4.7 Limitations and implications for future research

Several limitations of this analysis are worth noting. First, all conditions are based on self-report of symptoms or of a doctor's diagnosis and thus are subject to recall error. Second, the three-year follow-up period may be too short to capture the ultimate impact of risk drinking

on some types of medical conditions, e.g., on the organ damage associated with liver disease. At the same time, the associations between baseline risk drinking and social harms may to some extent derive from correlations between baseline and more recent or in-the-event risk drinking. Future analyses could distinguish long-term and proximal effects of risk drinking by comparing the magnitudes of associations for individuals with different drinking trajectories, i.e., among those whose consumption declined, remained stable and increased over the follow-up period.

The measure of risk drinking used in this analysis, frequency of drinking 5+/4+ drinks in a single day rather than in a single sitting or on a single occasion, may overstate the frequency with which respondents attained a blood alcohol level that increased their likelihood of psychomotor impairment. This distinction might be important, especially for outcomes such as violent behavior and driver's license revocation. The Wave 1 NESARC asked past year drinkers their frequency of drinking on multiple occasions during the same day. Based on the ratio of this frequency to their overall frequency of drinking, the proportion of drinking days that were divided into multiple drinking occasions varied from about 2 percent for non-risk or infrequent risk drinkers to about 6 percent for daily/near daily risk drinkers (data not shown). This suggests minimal differences between frequencies of drinking days and drinking occasions. At the same time, the Wave 2 NESARC included questions on the frequencies of drinking 5+ and 4+ drinks within a period of two hours or less, and these frequencies were substantially lower than the frequencies of drinking 5+/4+ drinks in a single day. Thus, the harms associated with frequency of risk drinking as defined in this analysis are likely conservative estimates of the harms that would be associated with those same frequencies for a more stringent definition of risk drinking.

Another potential limitation is that the implicit assumption that risk is invariant across population subgroups may be unwarranted. Risk drinking is far more normative in some population subgroups, e.g., young adults and males, than in others, and the extent to which risk drinking is correlated with social deviancy may affect associated risks, particularly for social harm and for substance use and other psychiatric disorders. In addition, vulnerabilities associated with age, gender, race/ethnicity and socioeconomic status may interact with frequency of risk drinking in predicting the risk of incident medical conditions and psychiatric disorders. Fortunately, the size of the longitudinal NESARC database will accommodate future testing for potential interactions such as these, enabling identification of population subgroups especially in need of intervention to reduce the harm associated with risk drinking.

4.8 Conclusions

The results of this paper provide strong evidence that frequent risk drinking is linked with the development of many different types of harm – evidence that could play an important illustrative role in the design of prevention programs and messages. This study's use of graduated levels of control revealed that the excess odds of harm *among* risk drinkers are far greater than the excess odds of harm that are independently attributable to risk drinking. This suggests that risk drinkers would benefit from interventions aimed at a broad range of lifestyle issues, e.g., smoking and obesity, in addition to their misuse of alcohol. Although the physical harm independently associated with risk drinking appeared to be limited to liver disease, it is important to note that risk drinking may have an important *indirect* role in causing physical harm through its positive association with smoking initiation and the development of nicotine dependence. The strong and clearly linear relationship between frequency of risk drinking and the incidence of alcohol dependence indicates that frequent risk drinking is a clear marker for alcoholism and a meaningful part of the alcoholic phenotype. These findings can be considered as generally supportive of other analytic techniques that have been used to argue for the inclusion of a consumption criterion for alcohol dependence (Saha et al., 2007). However, they

provide no information as to the relative sensitivity and specificity of various frequency thresholds as a criterion for alcohol dependence, nor do they address the question of whether some other quantity threshold, e.g., frequency of drinking 8+, 10+ or 12+ drinks, might be more appropriate for this purpose. (Although not available in the NESARC except as dichotomous measures of ever/never in the past year, frequencies associated with alternative quantities such as these currently exist in a number of smaller data sets and will be included in future NIAAA surveys.) Thus, this paper provides just one of many types of evidence and investigation required for the complex question as to the role of risk drinking in the classification of alcohol use disorders.

References

- Arif AA, Rohrer JE. Patterns of alcohol drinking and its association with obesity: data from the third national health and nutrition examination survey 1988–1994. *BioMed Central Public Health* 2005;5:pages for citation purposes are not given
- American Psychiatric Association. *Diagnostic and Statistical Manual of Mental Disorders*. 4. American Psychiatric Association; Washington, DC: 1994.
- Becker U, Deis A, Sørensen TIA, Grønbaek M, Borch-Johnsen K, Muller CF, Schnohr P, Jensen G. Prediction of risk of liver disease by alcohol intake, sex, and age: A prospective population study. *Hepatology* 1996;23:1025–1029. [PubMed: 8621128]
- Bradley KA, Bush KR, Davis TM, Dobie DJ, Burman ML, Rutter CM. Binge drinking among female veterans affairs patients: prevalence and associated risks. *Psychol Addict Behav* 2001;15:297–305. [PubMed: 11767260]
- Brown TT, Quain RD, Troxel AB, Gelfand JM. The epidemiology of sunburn in the US population in 2003. *J Am Acad Dermatol* 2006;55:577–583. [PubMed: 17010735]
- Cairney S, Cough A, Jaragba M, Maruff P. Cognitive impairment in Aboriginal people with heavy episodic patterns of alcohol use. *Addiction* 2007;102:909–915. [PubMed: 17523985]
- Chenet L, Britton A, Kalediene R, Petrauskiene J. Daily variations in deaths in Lithuania: the possible contribution of binge drinking. *Int J Epidemiol* 2001;30:743–748. [PubMed: 11511597]
- Cherpitel CJ, Bond J, Ye Y. Alcohol and injury: a risk room function analysis from the emergency room collaborative alcohol analysis project (ERCAAP). *Eur Addict Res* 2006;12:42–52. [PubMed: 16352902]
- Cherpitel CJ, Tam T, Midanik L, Caetano R, Greenfield T. Alcohol and non-fatal injury in the U.S. general population: a risk function analysis. *Accid Anal Prev* 1995;27:651–661. [PubMed: 8579696]
- Cottler LB, Grant BF, Blaine J, Mavreas V, Pull CB, Hasin DS, Compton WM, Rubio-Stipec M, Mager D. Concordance of DSM-IV alcohol and drug use disorder criteria and diagnoses as measured by the AUDADIS-ADR, CIDI and SCAN. *Drug Alcohol Depend* 1997;47:195–205. [PubMed: 9306045]
- Cunningham JA. Resolving alcohol-related problems with and without treatment: The effects of different problem criteria. *J Stud Alcohol* 1999;60:463–466. [PubMed: 10463801]
- Dawson DA. Alcohol and mortality from external causes. *J Stud Alcohol* 2001;62:790–797. [PubMed: 11838916]
- Dawson, DA.; Grant, BF.; Chou, PS. Gender differences in alcohol intake. In: Hunt, WA.; Zakhari, S., editors. *Stress, Gender and Alcohol Seeking Behavior*. Research Monograph No. 29, National Institute on Alcohol Abuse and Alcoholism; Bethesda, MD: 1995. p. 1-18.
- Dawson DA, Room R. Towards agreement on ways to measure and report drinking patterns and alcohol-related problems in adult general population surveys: the Skarpö Conference overview. *J Subst Abuse* 2000;12:1–21. [PubMed: 11288465]
- DeWit DJ, Adlaf EM, Offord DR, Ogborne AC. Age at first alcohol use: A risk factor for the development of alcohol use disorders. *Am J Psychiatry* 2000;157:745–750. [PubMed: 10784467]
- Edwards, G.; Anderson, P.; Babor, TF.; Casswell, S.; Ferrence, R.; Giesbrecht, N.; Godfrey, C.; Holder, H.; Lemmens, P.; Mäkelä, K.; Midanik, LT.; Norström, T.; Österberg, E.; Romelsjö, A.; Room, R.; Simpura, J.; Skog, O-J. *Alcohol Policy and the Public Good*. Oxford University Press; Oxford: 1994. p. 75-106.

- Funk D, Marinelli PW, Lê AD. Biological processes underlying co-use of alcohol and nicotine: neuronal mechanisms, cross-tolerance, and genetic factors. *Alc Res Health* 2006;29:186–192.
- Grant BF, Dawson DA. Age at onset of alcohol use and its association with DSM-IV alcohol abuse and dependence: Results from the National Longitudinal Alcohol epidemiologic Survey. *J Subst Abuse* 9:103–110. [PubMed: 9494942]
- Grant, BF.; Dawson, DA.; Hasin, DS. The Alcohol Use Disorders and Associated Disabilities Interview Schedule - Version for DSM-IV (AUDADIS-IV). National Institute on Alcohol Abuse and Alcoholism; Bethesda, MD: 2001.
- Grant BF, Dawson DA, Stinson FS, Chou PS, Pickering RP. The Alcohol Use Disorder and Associated Disabilities Schedule (AUDADIS): Reliability of alcohol and drug modules in a general population sample. *Drug Alcohol Depend* 2003;39:7–16. [PubMed: 12821201]
- Grant BF, Hasin DS, Stinson FS, Dawson DA, Chou SP, Ruan WJ, Huang B. Co-occurrence of 12-month mood and anxiety disorders and personality disorders in the U.S.: Results from the National Epidemiologic Survey on Alcohol and Related Conditions. *J Psychiatr Res* 2005;39:1–9. [PubMed: 15504418]
- Grant BF, Stinson FS, Dawson DA, Chou SP, Dufour MC, Compton W, Kaplan K. Prevalence and co-occurrence of substance use disorders and independent mood and anxiety disorders: results from the national Epidemiologic Survey on Alcohol and Related Conditions. *Arch Gen Psychiatry* 2004;61:807–816. [PubMed: 15289279]
- Grant BF, Stinson FS, Harford TC. Age at onset of alcohol use and DSM-IV alcohol dependence: A 12-year follow-up. *J Subst Abuse* 2001;13:493–504. [PubMed: 11775078]
- Hasin, DS.; Muthen, B.; Grant, BF. The dimensionality of DSM-IV alcohol abuse and dependence: Factor analysis in a clinical sample. In: Vrasti, R., editor. *Alcoholism: New Research Perspectives*. Gottingen, Germany: Hogrefe and Hubner; 1997. p. 27-39.
- Haynes JC, Farrell M, Singleton N, Meltzer H, Araya R, Lewis G, Wiles NJ. Alcohol consumption as a risk factor for anxiety and depression: results from the longitudinal; follow-up of the National Psychiatric Morbidity Survey. *Br J Psychiatry* 2005;9:554–551.
- Hingson RW, Hereen T, Winter MR. Age at drinking onset and alcohol dependence: Age at onset, duration and severity. *Arch Pediatr Adolesc Med* 2006;160:739–746. [PubMed: 16818840]
- Jarvenpaa T, Rinne JO, Koskenvuo M, Raiha I, Kaprio J. Binge drinking in midlife and dementia risk. *Am J Epidemiol* 2005;16:766–771.
- Kahn, HA. *An Introduction to Epidemiologic Methods*. Oxford University Press; New York NY: 1983. p. 57-58.
- Laatikainen T, Manninen L, Poikolainen K, Vartiainen E. Increased mortality related to heavy alcohol intake pattern. *J Epidemiol Comm Health* 2006;57:379–384.
- Little HJ. Behavioral mechanisms underlying the link between smoking and drinking. *Alc Res Health* 2000;24:215–224.
- Mäkelä P, Paljärvi T, Poikolainen K. Heavy and nonheavy drinking occasions, all-cause and cardiovascular mortality and hospitalizations: a follow-up study in a population with low consumption level. *J Stud Alcohol* 2005;66:722–728. [PubMed: 16459933]
- Malyutina S, Bobak M, Kurilovitch S, Gafarov V, Simonova G, Nikitin Y, Marmot M. Relation between heavy and binge drinking and all-cause and cardiovascular mortality in Novosibirsk, Russia: a prospective cohort study. *Lancet* 2002;360:1448–1454. [PubMed: 12433511]
- Mann RE, Suurvali HM, Smart RG. The relationship between alcohol use and mortality rates from injuries: a comparison of measures. *Am J Drug Alc Abuse* 2001;27:737–747.
- Moore AA, Endo JO, Carter KC. Is there a relationship between excessive drinking and functional impairment in older persons? *J Am Geriatr Soc* 2003;51:44–49. [PubMed: 12534844]
- Mukamal KJ, Maclure M, Muller JE, Mittleman MA. Binge drinking and mortality after acute myocardial infarction. *Circulation* 2005;112:3839–3845. [PubMed: 16365208]
- Muthen B, Grant BF, Hasin DS. The dimensionality of alcohol abuse and dependence” Factor analysis of DSM-III-R and proposed DSM-IV criteria in the 1988 National Health Interview Survey. *Addiction* 1993;88:1079–1090. [PubMed: 8401162]

- Murray RP, Connett JE, Tyas SL, Bond R, Ekuma O, Silversides CK, Barnes GE. Alcohol volume, drinking pattern, and cardiovascular disease morbidity and mortality: is there a U-shaped function? *Am J Epidemiol* 2002;155:242–248. [PubMed: 11821249]
- National Institute on Alcohol Abuse and Alcoholism. Helping Patients with Alcohol Problems: A Health Practitioners Guide. National Institute on Alcohol Abuse and Alcoholism; Bethesda, MD: 2004.
- Nelson CB, Rehm J, Ustun B, Grant BF, Chatterji S. Factor structure of DSM-IV substance disorder criteria endorsed by alcohol, cannabis, cocaine and opiate users: Results from the World Health Organization Reliability and Validity Study. *Addiction* 1999;94:843–855. [PubMed: 10665074]
- O’Connell J, Novins DK, Beals J, Croy C, Barón AE, Spicer P, Buchwald D. American Indian Service Utilization, Psychiatric Epidemiology, Risk and Protective Factors Project Team. The relationship between patterns of alcohol use and mental and physical health disorders in two American Indian populations. *Addiction* 2006;101:69–83. [PubMed: 16393193]
- Oesterle S, Hill KG, Hawkins JD, Guo J, Catalano RF, Abbott RD. Adolescent heavy episodic drinking trajectories and health in young adulthood. *J Stud Alcohol* 2004;65:204–212. [PubMed: 15151351]
- Okoro CA, Brewer RD, Naimi TS, Moriarty DG, Giles WH, Mokdad AH. Binge Drinking and Health Related Quality of Life. Do Popular Perceptions Match Reality? *Am J Prev Med* 2004;26:230–233. [PubMed: 15026103]
- Okosun IS, Seale JP, Daniel JB, Eriksen MP. Poor health is associated with episodic heavy alcohol use: evidence from a National Survey. *Public Health* 2005;119:509–517. [PubMed: 15826892]
- Paljärvi T, Mäkelä P, Poikolainen K. Pattern of drinking and fatal injury: a population-based follow-up study of Finnish men. *Addiction* 2005;100:1851–1859. [PubMed: 16367986]
- Pletcher MJ, Varosy P, Kiefe CI, Lewis CE, Sidney S, Hulley SB. Alcohol consumption, binge drinking, and early coronary calcification: findings from the coronary artery risk development in young adults (CARDIA) study. *Am J Epidemiol* 2005;161:423–433. [PubMed: 15718478]
- Pull CB, Saunders JB, Mavreas V, Cottler LB, Grant BF, Hasin DS, Blaine J, Mager D, Ustun B. Concordance between ICD-10 alcohol and drug use disorder criteria and diagnoses as measured by the AUDADIS-ADR, CIDI and SCAN: Results of a cross-national study. *Drug Alcohol Depend* 1997;47:207–216. [PubMed: 9306046]
- Rehm J, Greenfield TK, Rogers JD. Average volume of alcohol consumption, patterns of drinking, and all-cause mortality: results from the US National Alcohol Survey. *Am J Epidemiol* 2001;153:64–71. [PubMed: 11159148]
- Rehm J, Monga N, Adlaf E, Taylor B, Bondy SJ, Fallu JS. School matters: drinking dimensions and their effects on alcohol-related problems among Ontario secondary school students. *Alcohol Alcohol* 2005;40:569–574. [PubMed: 16157609]
- Research Triangle Institute. SUDAAN User’s Manual, Version 8. Research Triangle Institute; Research Triangle Park, NC: 2001.
- Rivara FP, Garrison mM, Ebel B, McCarty CA, Christakis DA. Mortality attributable to harmful drinking in the United States, 2000. *J Stud Alcohol* 2004;65:530–536. [PubMed: 15376828]
- Rose G. Sick individuals and sick populations. *Int J Epidemiol* 1992;14:32–28. [PubMed: 3872850]
- Rossow I, Ystgaard M, Hawton K, Madge N, Hewitt A, Van Heeringen C, de Wilde EJ, De Leo D, Fekete S, Sullivan C. Alcohol consumption and deliberate self-harm in adolescents. *Psychiatr Danub* 2006;18:article page numbers are not given
- Saha TD, Stinson FS, Grant BF. The role of alcohol consumption in future classification of alcohol use disorders. *Drug Alcohol Depend*. 2007Epub Jan 19
- San José B, Van de Mheen H, Van Oers JAM, Mackenbach JP, Garretsen HFL. The U-shaped curve: various health measures and alcohol drinking patterns. *J Stud Alcohol* 1998;60:725–731.
- Schmidt LG, Smolka M. Relapse prevention in alcoholics by cigarette smoking? Involvement of nicotine-dopaminergic mechanisms. *Alcohol* 2001;24:111–115. [PubMed: 11522432]
- Steffens AA, Moreira LB, Fuchs SC, Wiehe M, Gus M, Fuchs FD. Incidence of hypertension by alcohol consumption: is it modified by race? *J Hypertension* 2006;24:1489–1492.
- Stranges S, Notaro J, Freudenheim JL, Calogero RM, Muti P, Farinaro E, Russell M, Nochajski TH, Trevisan M. Alcohol drinking pattern and subjective health in a population-based study. *Addiction* 2006;101:1265–1276. [PubMed: 16911725]

- Tolstrup JS, Jensen MK, Tjenneland A, Overvad K, Grønbaek M. Drinking pattern and mortality in middle-aged men and women. *Addiction* 2004;99:323–330. [PubMed: 14982545]
- Wechsler H, Davenport A, Dowdall G, Moeykens B, Castillo S. Health and behavioral consequences of binge drinking in college. A national survey of students at 140 campuses. *JAMA* 1994;272:1672–1677. [PubMed: 7966895]
- Wechsler H, Nelson TF. Binge drinking and the American college student: what's five drinks? *Psychol Addict Behav* 2001;15:287–291. [PubMed: 11767258]
- Zhang J, Yu KF. What's the relative risk? *JAMA* 1998;280:1690–1691. [PubMed: 9832001]

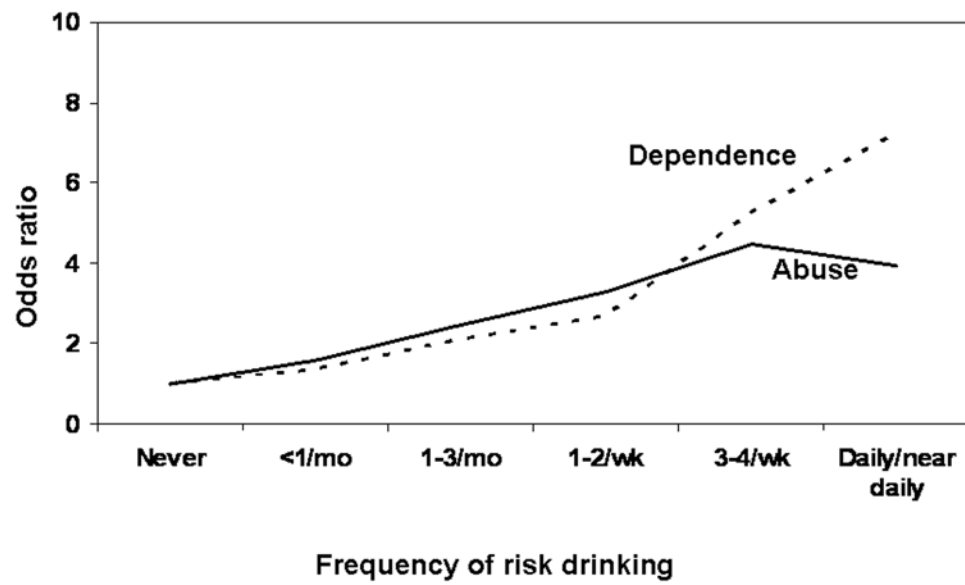


Figure 1. Adjusted odds ratios for incidence of alcohol abuse and dependence, by frequency of risk drinking

Table 1

Percentage distribution and selected characteristics of baseline drinkers^a, by frequency of risk drinking in year preceding Wave 1 interview

	Frequency of risk drinking				
	Never	<1/month	1-3/month	1-2/week	3-4/week
Percentage of baseline drinkers ^a	59.9 (0.6)	16.7 (0.3)	9.1 (0.2)	8.5 (0.3)	2.8 (0.1)
Characteristics at baseline:					
Mean age	46.8 (0.2)	37.8 (0.3)	36.0 (0.4)	34.9 (0.4)	35.9 (0.7)
% male	47.2 (0.6)	54.0 (1.1)	57.9 (1.4)	67.8 (1.3)	68.9 (2.2)
% non-Hispanic white	80.6 (1.2)	82.7 (1.3)	80.3 (1.5)	76.9 (1.6)	78.9 (2.3)
% married	69.1 (0.6)	62.8 (1.1)	54.2 (1.5)	47.3 (1.6)	44.9 (2.5)
% employed	76.8 (0.5)	90.4 (0.6)	90.0 (0.9)	91.3 (0.7)	88.9 (1.7)
% attended college	63.7 (0.7)	67.5 (1.0)	61.4 (1.5)	58.8 (1.6)	55.9 (2.4)
Mean income (\$000s)	57.8 (0.9)	60.8 (1.3)	55.6 (1.4)	47.5 (1.3)	46.6 (2.0)
% in fair/poor health	10.3 (0.4)	8.2 (0.6)	7.6 (0.7)	8.2 (0.7)	11.5 (1.5)
% overweight (BMI = 25.0-29.9)	35.3 (0.5)	36.7 (1.0)	33.5 (1.3)	36.3 (1.3)	40.2 (2.4)
% obese (BMI ≥ 30.0)	36.1 (0.5)	37.3 (1.0)	34.0 (1.3)	36.6 (1.2)	40.9 (2.5)
% smokers	22.5 (0.5)	37.5 (1.0)	45.9 (1.3)	53.9 (1.5)	60.8 (2.3)
% illicit drug users	3.3 (0.2)	9.7 (0.7)	15.5 (0.9)	21.2 (1.3)	25.2 (2.3)
% with mood or anxiety disorders	15.4 (0.4)	22.3 (0.8)	20.5 (1.1)	19.4 (1.1)	21.8 (2.0)
% with personality disorders	13.7 (0.4)	19.8 (0.9)	18.5 (1.0)	19.8 (1.3)	22.0 (2.1)
Mean ADY ^b ethanol intake	0.160 (.004)	0.315 (.009)	0.565 (.014)	1.251 (.049)	2.911 (.094)
Mean ADY ^b ethanol consumed on nonrisk drinking days	0.159 (.004)	0.268 (.009)	0.322 (.012)	0.222 (.013)	0.168 (.017)
Mean oz. ethanol consumed per risk drinking day	NA	3.73 (.06)	4.21 (.09)	5.16 (.20)	6.01 (.18)
Mean years since first drink	26.3 (0.2)	19.5 (0.3)	18.0 (0.4)	17.0 (0.4)	18.8 (0.7)
N of cases	13,507	3,553	2,001	1,794	618
					649

Note: All differences by frequency of risk drinking are statistically significant, $p < .0001$.

^a Individuals who drank at least 1 drink in the year preceding the Wave 1 interview and who were reinterviewed at Wave 2

^b Average daily volume, i.e., annual volume/365

Table 2

Adjusted^a odds ratios and 95% confidence intervals for association between frequency of risk drinking at Wave 1 and incidence/occurrence of selected outcomes between Wave 1 and Wave 2

Incidence of:	Never	Frequency of risk drinking				Daily/Near daily
		<1/month	1-3/month	1-2/week	3-4/week	
Alcohol abuse (n = 13,894)	1.00 (Ref)	1.59 (1.25-2.02)	2.46 (1.84-3.28)	3.29 (2.47-4.38)	4.48 (2.65-7.58)	3.93 (2.40-6.44)
Alcohol dependence (n = 18,114)	1.00 (Ref)	1.35 (1.05-1.73)	2.10 (1.54-2.86)	2.69 (2.00-3.62)	5.27 (3.26-8.52)	7.23 (4.75-11.00)
Drug use (n = 15,018)	1.00 (Ref)	1.14 (0.86-1.51)	1.20 (0.87-1.66)	1.63 (1.19-2.24)	1.74 (1.09-2.79)	1.87 (1.21-2.88)
Drug abuse (n = 18,822)	1.00 (Ref)	1.20 (0.83-1.73)	1.28 (0.83-1.95)	1.20 (0.77-1.87)	1.56 (0.88-2.77)	1.47 (0.80-2.73)
Drug dependence (n = 20,669)	1.00 (Ref)	1.14 (0.52-2.49)	1.39 (0.78-2.48)	2.36 (1.51-4.63)	1.30 (0.55-3.11)	2.22 (1.04-4.76)
Tobacco use (n = 10,418)	1.00 (Ref)	1.51 (1.01-2.25)	2.06 (1.33-3.20)	2.71 (1.75-4.18)	2.61 (1.12-6.10)	4.67 (2.16-10.10)
Nicotine dependence (n = 17,061)	1.00 (Ref)	1.32 (1.01-1.72)	1.49 (1.10-2.02)	1.77 (1.26-2.48)	1.94 (1.26-2.99)	3.03 (1.92-4.79)
Any mood disorder (n = 16,481)	1.00 (Ref)	0.89 (0.72-1.10)	0.94 (0.71-1.26)	0.74 (0.55-1.00)	0.94 (0.54-1.66)	1.07 (0.69-1.65)
Any anxiety disorder (n = 17,264)	1.00 (Ref)	1.03 (0.81-1.31)	1.13 (0.85-1.51)	1.09 (0.80-1.48)	0.93 (0.53-1.65)	1.21 (0.77-1.88)
Arteriosclerosis (n = 21,090)	1.00 (Ref)	0.65 (0.36-1.19)	1.07 (0.55-2.08)	0.81 (0.36-1.83)	0.36 (0.08-1.77)	0.45 (0.16-1.27)
Hypertension (n = 17,807)	1.00 (Ref)	0.93 (0.75-1.15)	1.01 (0.77-1.32)	1.04 (0.77-1.40)	1.43 (0.95-2.13)	1.31 (0.92-1.88)
Any liver disease (n = 21,200)	1.00 (Ref)	1.04 (0.81-1.35)	0.99 (0.70-1.41)	0.96 (0.69-1.33)	0.85 (0.47-1.51)	1.38 (0.90-2.13)
Any gastric disease (n = 20,191)	1.00 (Ref)	1.21 (0.62-2.35)	1.62 (0.79-3.32)	2.78 (1.32-5.85)	2.40 (0.47-12.23)	4.76 (2.29-9.88)
Arthritis (n = 18,200)	1.00 (Ref)	0.89 (0.66-1.18)	0.83 (0.57-1.20)	0.88 (0.61-1.27)	0.66 (0.27-1.57)	0.90 (0.48-1.68)
Any occurrence since Wave 1 of:	1.00 (Ref)	0.93 (0.72-1.19)	1.02 (0.75-1.38)	1.01 (0.74-1.37)	0.66 (0.39-1.09)	0.92 (0.60-1.40)
Divorce/separation (n = 11,665)	1.00 (Ref)	1.36 (1.03-1.80)	1.36 (0.90-2.04)	1.51 (0.99-2.30)	1.94 (1.00-3.76)	2.63 (1.51-4.60)
Neglect school/work (n = 2,1313)	1.00 (Ref)	0.91 (0.71-1.17)	0.94 (0.72-1.23)	0.99 (0.74-1.32)	0.77 (0.52-1.12)	1.39 (0.97-1.98)
Violent behavior (n = 21,313)	1.00 (Ref)	0.97 (0.72-1.30)	1.23 (0.89-1.72)	1.09 (0.78-1.54)	1.03 (0.64-1.65)	1.61 (1.05-2.47)
Driver's license revoked (n = 21,313)	1.00 (Ref)	1.28 (0.98-1.67)	1.37 (1.00-1.88)	1.81 (1.30-2.54)	2.19 (1.55-3.09)	2.11 (1.38-3.22)
Abuse of spouse (n = 11,665)	1.00 (Ref)	0.93 (0.70-1.25)	1.21 (0.85-1.70)	1.27 (0.87-1.85)	1.76 (0.90-3.45)	2.06 (1.22-3.46)

Note: Shaded cells denote OR that are significantly different from 1.00.

^a Adjusted (as appropriate) for age, sex, race/ethnicity, whether married, whether employed, whether attended/completed college, health status, body mass index, tobacco use, drug use, any mood or anxiety disorder, any personality disorder, family history of alcoholism, volume of ethanol intake consumed on non-risk drinking days and mean quantity of drinks consumed on risk drinking days, and years since first drink, all in the year preceding the Wave 1 interview. Family history of alcoholism was used only in the models predicting incidence of alcohol abuse and dependence. The models predicting incidence of tobacco and drug use excluded adjustment for baseline use of these substances. Rather than adjusting for any mood or anxiety disorder, models predicting incidence of any mood disorder adjusted for any baseline anxiety disorder and those predicting incidence of any anxiety disorder adjusted for any baseline mood disorder. The models predicting neglect of school or work responsibilities and violence adjusted for any personality disorder excluding antisocial, because these outcomes were measured using symptom item indicators for antisocial PD.

Table 3

Odds ratios and 95% confidence intervals for association between engaging in risk drinking on a daily/near daily basis at Wave 1 and incidence/occurrence of selected outcomes between Wave 1 and Wave 2, showing successive levels of adjustment: Referent = drinkers who never engaged in risk drinking

	No adjustment	Adjusted for age, sex and race/ethnicity	Odds ratios adjusted for:		
			Additionally adjusted for SES, BMI and health a	Additionally adjusted for other substance use & comorbid disorders a	Additionally adjusted for volume of non-risk consumption, mean quantity consumed on risk drinking days & years since 1 st drink
Incidence of:					
Alcohol abuse (n = 13,894)	6.69 (4.20–10.66)	5.86 (3.64–9.44)	5.00 (3.12–8.03)	4.46 (2.81–7.10)	3.93 (2.40–6.44)
Alcohol dependence (n = 18,114)	10.52 (7.38–14.99)	10.08 (6.85–14.84)	8.41 (5.73–12.35)	7.55 (5.02–11.34)	7.23 (4.75–11.00)
Drug use (n = 15,018)	3.44 (2.28–5.20)	3.16 (2.10–4.77)	2.43 (1.62–3.70)	2.24 (1.47–3.41)	1.87 (1.21–2.88)
Drug abuse (n = 18,822)	3.93 (2.26–6.85)	3.25 (1.84–5.74)	2.47 (1.39–4.38)	2.06 (1.15–3.71)	1.47 (0.80–2.73)
Drug dependence (n = 20,669)	6.20 (3.09–12.44)	4.80 (2.36–9.74)	3.38 (1.62–7.06)	2.90 (1.45–5.81)	2.22 (1.04–4.76)
Tobacco use (n = 10,418)	6.90 (3.65–13.04)	5.11 (2.72–9.60)	4.19 (2.10–8.33)	4.37 (2.17–8.79)	4.67 (2.16–10.10)
Nicotine dependence (n = 17,061)	4.48 (3.15–6.36)	4.01 (2.81–5.73)	2.97 (2.01–4.37)	2.87 (1.93–4.28)	3.03 (1.92–4.79)
Any anxiety disorder (n = 16,481)	1.58 (1.03–2.40)	1.86 (1.22–2.83)	1.49 (0.98–2.28)	1.27 (0.83–1.94)	1.07 (0.69–1.65)
Any mood disorder (n = 17,264)	1.37 (0.92–2.04)	1.51 (1.01–2.24)	1.42 (0.95–2.11)	1.26 (0.83–1.90)	1.21 (0.77–1.88)
Any anxiety disorder (n = 21,090)	0.44 (0.18–1.10)	0.65 (0.26–1.64)	0.53 (0.21–1.36)	0.47 (0.18–1.22)	0.45 (0.16–1.27)
Arteriosclerosis (n = 17,807)	1.17 (0.86–1.59)	1.43 (1.04–1.97)	1.31 (0.94–1.83)	1.29 (0.93–1.79)	1.31 (0.92–1.88)
Hypertension (n = 20,028)	1.20 (0.79–1.81)	1.58 (1.03–2.42)	1.33 (0.88–2.02)	1.32 (0.89–1.96)	1.38 (0.90–2.13)
Any CHD (n = 21,200)	5.93 (3.04–11.56)	5.88 (2.99–11.55)	5.00 (2.61–9.57)	4.62 (2.40–8.89)	4.76 (2.29–9.88)
Any liver disease (n = 20,191)	0.98 (0.55–1.75)	1.27 (0.71–2.29)	1.06 (0.59–1.91)	0.90 (0.50–1.60)	0.90 (0.48–1.68)
Any gastric disease (n = 18,200)	1.00 (0.71–1.40)	1.31 (0.92–1.86)	1.15 (0.81–1.63)	1.02 (0.72–1.45)	0.92 (0.60–1.40)
Arthritis (n = 18,200)					
Any occurrence since Wave 1 of:					
Divorce/separation (n = 11,665)	3.47 (2.21–5.43)	3.44 (2.19–5.40)	2.98 (1.86–4.77)	2.39 (1.48–3.85)	2.63 (1.51–4.60)
Neglect school/work (n = 2,1313)	3.77 (2.79–5.11)	3.27 (2.41–4.44)	2.42 (1.75–3.36)	1.71 (1.23–2.37)	1.39 (0.97–1.98)
Violent behavior (n = 21,313)	5.77 (4.03–8.26)	4.35 (3.03–6.24)	3.34 (2.25–4.96)	2.13 (1.40–3.24)	1.61 (1.05–2.47)
Driver's license revoked (n = 21,313)	6.23 (4.44–8.73)	4.41 (3.04–6.38)	3.04 (2.05–4.52)	2.10 (1.40–3.15)	2.11 (1.38–3.22)
Abuse of spouse (n = 11,665)	2.67 (1.73–4.22)	2.99 (1.90–4.72)	2.52 (1.58–4.04)	2.15 (1.32–3.52)	2.06 (1.22–3.46)

Note: Shaded cells denote OR that are significantly different from 1.00.

^a See Table 1 footnote for details on covariates used for various outcomes.

Table 4

Odds ratios and 95% confidence intervals for association between engaging in risk drinking once or twice a week at Wave 1 and incidence/occurrence of selected outcomes between Wave 1 and Wave 2, showing successive levels of adjustment: Referent = drinkers who never engaged in risk drinking

		Odds ratios adjusted for:				
	No adjustment	Adjusted for age, sex and race/ethnicity	Additionally adjusted for SES, BMI and health	Additionally adjusted for other substance use and comorbid disorders	Additionally adjusted for volume of non-risk consumption, mean quantity consumed on risk drinking days & years since 1 st drink	
Incidence of:						
Alcohol abuse (n = 13,894)	6.24 (4.91–7.93)	4.24 (3.26–5.52)	4.18 (3.20–5.45)	3.81 (2.89–5.04)	3.29 (2.47–4.38)	
Alcohol dependence (n = 18,114)	5.43 (4.16–7.08)	3.55 (2.68–4.72)	3.48 (2.62–4.63)	3.10 (2.30–4.17)	2.69 (2.00–3.62)	
Drug use (n = 15,018)	2.88 (2.21–3.75)	2.03 (1.54–2.68)	1.90 (1.43–2.53)	1.80 (1.35–2.40)	1.63 (1.19–2.24)	
Drug abuse (n = 18,822)	3.28 (2.23–4.82)	1.81 (1.24–2.64)	1.74 (1.19–2.53)	1.52 (1.03–2.24)	1.20 (0.77–1.87)	
Drug dependence (n = 20,669)	5.89 (3.47–9.99)	3.13 (1.84–5.34)	2.94 (1.73–5.00)	2.65 (1.54–4.57)	2.36 (1.51–4.63)	
Tobacco use (n = 10,418)	3.96 (2.75–5.69)	2.50 (1.68–3.71)	2.60 (1.75–3.86)	2.58 (1.73–3.85)	2.71 (1.75–4.18)	
Nicotine dependence (n = 17,061)	2.37 (1.85–3.04)	1.93 (1.48–2.52)	1.75 (1.34–2.30)	1.71 (1.29–2.25)	1.77 (1.26–2.48)	
Any mood disorder (n = 16,481)	1.06 (0.80–1.41)	0.99 (0.74–1.32)	0.91 (0.67–1.23)	0.84 (0.61–1.15)	0.74 (0.55–1.00)	
Any anxiety disorder (n = 17,264)	1.23 (0.93–1.62)	1.11 (0.83–1.50)	1.10 (0.82–1.49)	1.03 (0.76–1.39)	1.09 (0.80–1.48)	
Arteriosclerosis (n = 21,090)	0.38 (0.16–0.88)	0.98 (0.42–2.29)	0.93 (0.40–2.17)	0.85 (0.37–1.97)	0.81 (0.36–1.83)	
Hypertension (n = 17,807)	0.62 (0.48–0.82)	1.07 (0.81–1.41)	1.03 (0.77–1.37)	1.02 (0.76–1.36)	1.04 (0.77–1.40)	
Any CHD (n = 20,028)	0.55 (0.40–0.75)	0.90 (0.65–1.24)	0.88 (0.64–1.23)	0.91 (0.66–1.25)	0.96 (0.69–1.33)	
Any liver disease (n = 21,200)	2.56 (1.32–4.96)	2.96 (1.45–6.04)	2.90 (1.44–5.87)	2.80 (1.36–5.80)	2.78 (1.32–5.85)	
Any gastric disease (n = 20,191)	0.68 (0.50–0.94)	0.99 (0.71–1.37)	0.95 (0.68–1.33)	0.85 (0.60–1.19)	0.88 (0.61–1.27)	
Arthritis (n = 18,200)	0.60 (0.46–0.79)	1.14 (0.86–1.51)	1.13 (0.85–1.51)	1.05 (0.78–1.40)	1.01 (0.74–1.37)	
Any occurrence since Wave 1 of:						
Divorce/separation (n = 11,665)	2.12 (1.51–2.97)	1.58 (1.11–2.23)	1.54 (1.09–2.18)	1.33 (0.91–1.93)	1.51 (0.99–2.30)	
Neglect school/work (n = 2,1313)	2.49 (1.95–3.19)	1.65 (1.28–2.13)	1.45 (1.12–1.88)	1.16 (0.89–1.50)	0.99 (0.74–1.32)	
Violent behavior (n = 21,313)	3.47 (2.58–4.66)	1.99 (1.47–2.69)	1.83 (1.35–2.47)	1.32 (0.97–1.80)	1.09 (0.78–1.54)	
Driver's license revoked (n = 21,313)	4.82 (3.69–6.31)	2.80 (2.10–3.72)	2.45 (1.85–3.30)	1.85 (1.36–2.52)	1.81 (1.30–2.54)	
Abuse of spouse (n = 11,665)	1.81 (1.29–2.55)	1.58 (1.10–2.28)	1.46 (1.01–2.12)	1.34 (0.93–1.94)	1.27 (0.87–1.85)	

Note: Shaded cells denote OR that are significantly different from 1.00.

^a See Table 1 footnote for details on covariates used for various outcomes.