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Re-examining the relationship between alcohol consumption and coronary heart disease with a new lens

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Abstract

Moderate alcohol consumption has been related to lower risk of coronary heart disease (CHD) in the literature. To examine whether alcohol drinking during the past 12 months and heaviest drinking period were differentially associated with the risk of CHD, we designed a case-control study using a population-based health survey of U.S. adults conducted from 2012 to 2013. Respondents who reported to have doctor-ascertained CHD served as cases (n = 1671), and those free of CHD and other alcohol-related health conditions served as controls (n = 17,629) in logistic regressions. Sex-specific quartiles of average daily ethanol intake were ascertained and calculated for the past 12 months and during the period of heaviest lifetime drinking. We further split current drinkers into reducers and non-reducers (past 12 months relative to the heaviest drinking period) to examine CHD risk profiles in association with the 12-month drinking level. Current-drinker reducers (AOR, 95% CI = 1.57 [1.10–2.27] for men; AOR, 95% CI = 1.33 [1.02–1.72] for women) and former drinkers (AOR, 95% CI = 2.06 [1.43–2.97] for men; AOR, 95% CI = 1.51 [1.19–1.92] for women) more often had CHD than lifetime abstainers. Male heavy drinkers during the heaviest drinking period (AOR, 95% CI = 2.25 [1.52–3.32]) were more likely to manifest CHD than lifetime abstainers. In addition, individuals with diagnosed CHD were significantly more likely to have reduced drinking in the past. A change in alcohol consumption over the life course among former and current drinkers may distort the true alcohol-CHD relationship.

Keywords

Alcohol intake; Coronary heart disease; Life course; Sick quitter hypothesis

1. Introduction

Much of the literature for the past three decades has demonstrated a J-shaped or U-shaped relationship between alcohol consumption and several cardiovascular disease (CVD) outcomes, with a cardioprotective effect associated with light-to-moderate drinking levels relative to abstaining or drinking heavily (Corrao et al., 2000; de Labry et al., 1992; Di Castelnuovo et al., 2006). A former drinker (sick quitter) effect has been a longstanding

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Conflicts of interest

The authors declare no conflict of interest.

criticism of earlier studies and meta-analyses; the J-shaped/U-shaped relationship may be the result of mixing lifetime abstainers and former drinkers as the reference group (Shaper, 1995a, 1995b; Shaper et al., 1988). Nonetheless, some meta-analysis (Roerecke and Rehm, 2011) and other studies (Costanzo et al., 2010; Roerecke and Rehm, 2012; Ronksley et al., 2011) also confirmed that the J-shaped relationship between alcohol consumption and several CVD outcomes, even when only lifetime abstainers constituted the reference group.

However, separating former drinkers and abstainer categories cannot completely address the sick quitter effect. Long-term abstainers may self-identify as “lifetime abstainers” in health surveys (Caldwell et al., 2006; Rehm et al., 2008). In other words, some lifetime abstainers may be former drinkers. On the other hand, individuals with long-standing illnesses were more likely to report themselves as lifetime abstainers (Naimi et al., 2005; Ng Fat et al., 2014); a change in long-standing illness was associated with ceasing alcohol consumption, or a reduction to special occasion drinking, compared with persistent drinking (Ng Fat et al., 2014). Inclusion of occasional drinkers in the abstainer category may also be a source of bias, but only a minority of studies have excluded occasional drinkers from the “non-drinker” reference category. Shaper and Wannamethee (2000) suggested the use of the occasional drinker as the reference group. However, the occasional drinker category may still be a mixture of those who voluntarily control their drinking to a low level during their lifetime and those who reduce alcohol consumption over time (Zhao et al., 2017).

Although some evidence for lower risk of coronary heart disease (CHD) associated with low-to-moderate alcohol consumption was derived from prospective cohort studies, exposure to alcohol is typically measured at baseline and tracked during the follow-up period (Britton, 2010; Emberson et al., 2005; Mukamal et al., 2003; Sesso et al., 2000; Walsh et al., 2002). Most of these studies assumed that consumption levels measured at baseline represent habitual exposure and are stable during the study period. However, there is strong epidemiologic evidence that alcohol consumption levels change over the life course (Fan et al., 2006; Fan et al., 2008b; Fillmore, 1987; Temple and Fillmore, 1985). Thus, it is likely that individuals at baseline may have already modified their drinking patterns and may continue to do so during the follow-up.

An individual changes his/her drinking habit constantly over his/her lifetime. Reduction of consumption over time may bias the drinking-CHD relationship toward a favorable effect of drinking. This cross-sectional study attempts to decipher the effects of both quitting and reduction on alcohol-CHD relationship. Using a sample from a large epidemiologic study among the U.S. general population—the National Epidemiologic Survey on Alcohol and Related Conditions-III (NESARC–III) (Grant et al., 2014), we attempted to answer these research questions: 1) Is drinking level during the heaviest drinking history directly associated with higher risk for CHD? 2) Do current-drinker reducers possess similar CHD profiles as former drinkers? 3) Does current drinking provide any protection against CHD?

2. Material and methods

2.1. Data source

The NESARC-III is a national representative survey of 36,309 adults aged 18 years and older residing in households and select group quarters in the United States from 2012 to 2013 (Grant et al., 2014). Respondents were selected through multistage probability sampling. Black, Asian, and Hispanic household members were oversampled. Data were adjusted for nonresponse and weighted to represent the civilian U.S. population based on the 2012 American Community Survey (Bureau of the Census, 2013). The household response rate was 72%; person level response rate, 84%; and overall response rate, 60.1%; comparable with other current U.S. surveys (Adams et al., 2012; Hedden et al., 2012).

2.2. Measures

2.2.1. Coronary heart disease during the past 12 months—The Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS) from the *Diagnostic and Statistical Manual on Mental Disorders: DSM-5,* was the diagnostic interview used in the NESARC-III. In Section 14 of the NESARC-III, thirty medical conditions that might be related to alcohol consumption were queried using questions that began with “during the last 12 months, did you have …?” If the answer was yes, he/she was then asked “has a doctor or other health professional told you that you had …” (see Appendix A for the list of the health conditions). Two of these chronic conditions pertain to CHD: chest pain or angina; a heart attack or myocardial infarction. Respondents who reported either or both doctor-ascertained conditions were classified as having CHD (n = 1671). Those who did not report CHD or any of the other alcohol-related health conditions (Appendix A) assessed in the NESARC-III were included in the non-case or comparison group (n = 17,629). Some of these health conditions are commonly recognized risk factors for CHD (e.g., high blood pressure, high cholesterol, high triglycerides, diabetes, stroke, rapid heartbeat, or tachycardia), others may increase the risk of CHD (e.g., pneumonia, influenza, tuberculosis, liver disease, neurologic conditions, osteoporosis, arthritis, STD) and can be viewed as comorbid conditions related to alcohol consumption. According to the principle of epidemiology, the control or comparison group may be contaminated or confounded if these individuals are included (Rothman and Greenland, 1998).

2.2.2. Drinking status—Drinkers were those who consumed at least one alcohol drink during their lifetime (“in your entire life, have you had at least 1 drink of any kind of alcohol, not counting small tastes or sips?”). Current drinkers were those who had at least one drink of any kind of alcohol during the last 12 months. Former drinkers were those who consumed at least one drink of any kind of alcohol prior to, but not during, the past 12 months. Lifetime abstainers were those who had never drank one alcohol drink during their lifetime. We further split current drinkers into two groups, reducers and non-reducers, based on the response to the question “Has there been a period of at least one year when you drank more heavily than in the past 12 months?”

2.2.3. Average daily intake during the past 12 months—The NESARC-III contains detailed questions about past 12-month alcohol consumption. For each beverage

type (coolers, beer, wine, and liquor), there are questions about the usual frequency of drinking, quantity of drinks consumed on drinking days, and size of drinks. Flashcards showing life-sized photographs of different types of glasses, with various fill levels designated in ounces, were provided to help respondents report drink size. The amount of ethanol in each drink was calculated using an ethanol conversion factor—the proportion of each drink that is pure alcohol. The estimates of total ethanol consumption during the past year were calculated by summing beverage-specific volumes across the four individual beverage types. Dividing this annual total by 365 yields the average daily volume of ethanol intake (Dawson, 2011).

We created drinking level categories by sex based on the consistent observation that women usually drink less and have lower thresholds for harm than men (Dawson, 2011). We labeled the four drinker quartiles “very light drinker”, “light drinker”, “moderate drinker”, and “heavy drinker to reflect the relative position of respondent’s drinking level within the sample in terms of drinking volume. Reliability of 12-month drinking patterns examined in two large general population studies were good to excellent (Kappa 0.59–0.99) (Grant et al., 2003; Grant et al., 1995).

2.2.4. Average daily intake during the period of heaviest drinking—

Respondents were asked “has there ever been a period of at least one year when you drank more heavily than in the past 12 months?” Respondents who answered “yes” to this question were classified as former drinkers who stopped drinking or reducers who had reduced their drinking prior to the past 12 months. Respondents were then asked the age at which they drank the most during their lifetime. Drinking frequency, usual, and largest quantities were ascertained for that period. Three drinking pattern variables (volume, frequency, and intensity) were created in the same manner as those for the past 12 months; “very light drinker”, “light drinker”, “moderate drinker”, or “heavy drinker” was used to represent the relative position of a respondent’s drinking level in terms of drinking volume for the period of heaviest drinking. Test–retest reliability for drinking patterns, including drinking volumes for the period of heaviest drinking assessed in a general population sample, were excellent (Kappa > 0.71) (Grant et al., 2003; Grant et al., 1995).

2.2.5. Covariates—Concurrent use of alcohol with tobacco and illicit drugs is common (Saha et al., 2018). While tobacco use has long been established to be a risk factor for CHD, drug use was also recognized to be a significant risk factor/trigger for myocardial ischemia and infarction (Bergstrom and Keller, 1992; Finsterer and Ohnsorge, 2013), especially among young adults (Rubin and Borden, 2012). Tobacco use status was ascertained for current and lifetime use of five separate types of tobacco: cigarettes, cigars, pipes, snuff or chewing tobacco, and E-cigarettes or E-liquid. Three categories were created: current (past year) use; former (prior to past year only) use; never used. Any lifetime drug use or drug use disorder (DUD) included a lifetime use and diagnosis of sedative, tranquilizer, painkiller, stimulant, cannabis, cocaine/crack, hallucinogen, inhalant/solvent, heroin, or other illicit drug use disorder defined in terms of the *Diagnostic and Statistical Manual of Mental Disorders: DSM-5* (American Psychiatric Association, 2013). Drug-specific diagnoses were aggregated to yield any lifetime DUD. Three categories were created: never used illicit

drugs; any non-dependent use of illicit drugs, and any dependent use of illicit drugs. Test–retest reliabilities of the AUDADIS measures of nicotine use, listed under DSM-5 drug use disorders, were fair to excellent (Grant et al., 2003, 2015; Hasin et al., 2015).

We also included the following sociodemographic covariates in the regression analysis: race/ethnicity (White, Black, Native American, Asian/Pacific Islander, Hispanic); age at interview (18–29, 30–44, 45–64, ≥65 years); marital status (married/cohabiting, widowed/separated/divorced, never married); educational attainment (less than high school, high school, some college or higher); family income (< $19,999, $20,000–$34,999, $35,000–$69,999, ≥$70,000); urbanicity (urban, rural); and region (Northeast, Midwest, South, West).

2.3. Statistical analysis

We used SAS 9.4 to conduct all analyses (SAS Institute, 2013). Descriptive analyses for continuous and categorical variables by drinking status and gender were conducted using PROC GLM and PROC FREQ, respectively. Pairwise comparisons were performed for continuous variables between least-square means after Bonferroni adjustment. Chi-square tests were performed for categorical variables. Logistic regression models were constructed to examine associations between drinking level/status during the past 12 months and CHD, controlling for the covariates. The respondents were categorized as lifetime abstainers, former drinkers, current drinker reducers, or current drinker non-reducers. Four quartile drinker groups (very light, light, moderate, and heavy) based on 12-month average daily intake levels were formed for current drinkers. For each quartile, we further split the respondents into reducers and non-reducers to examine their association with CHD risk profiles. Because it is debated which group is more appropriate to be the reference group, we conducted logistic regressions using lifetime abstainers as the reference group and, again, using the lowest drinking level as the reference group. Linear and quadratic trends were examined among drinkers only. The analyses using drinking intensity (drinks per drinking day) and frequency yielded similar patterns; therefore, only analyses based on average volume were presented. Another set of logistic regression analyses were conducted relating quartiles of drinking levels during the heaviest drinking period with CHD. Finally, we examined whether individuals with CHD were more likely to have had a drinking period that was heavier than the past 12 months. Most analyses were stratified by sex. A p value of 0.05 was determined to be statistically significant.

3. Results

3.1. Characteristics of the study sample

The study sample was comprised of roughly half men and half women aged 18 to 90 years with a mean of 38.9 years. About 13.4% were lifetime abstainers, about 12.7% were former drinkers, and 73.9% were current drinkers. Nearly 40% of current drinkers in the study sample reported they had a period of at least one year when they drank more heavily than in the past 12 months. The mean age difference between the age at interview and the age at which the respondent began to drink the most was 12.4 years. Former drinkers were about 8 years older than current drinkers and lifetime abstainers. Among male current drinkers, the reducers were 2.2 years older than non-reducers ($p < 0.001$), on average. No age difference

was found for reducers and non-reducers among female current drinkers. For both men and women, current drinker non-reducers began drinking the most at an older age (late 20s) (the heaviest level was equivalent to the current level for this group), while current drinker reducers and former drinkers began drinking the most at a younger age (early 20s). Current drinker reducers reported the highest average volume drunk during the heaviest drinking period, followed by former drinkers and current drinker non-reducers. Among current drinkers, reducers still drank at a higher volume than non-reducers for both men and women during the past 12 months. A disproportionally high number of current drinker reducers were current tobacco users (one-third for women, half for men). The prevalence of lifetime dependent and non-dependent use of illicit drugs were particularly high among this group. The descriptive characteristics of the study sample by drinking status and sex are shown in Tables 1 and 2.

3.2. Association of drinking volume during heaviest drinking period with CHD

Male heavy drinkers during their heaviest drinking period were twice more likely to have CHD than the lifetime abstainers (AOR = 2.09, 95% CI = 1.44–3.03) and 1.5 times more likely to have CHD than the very light drinkers (AOR = 1.54, 95% CI = 1.17–2.01) (Table 3). For women, very light drinkers (AOR = 1.28, 95% CI = 1.01–1.63) were 1.3 times more likely to have CHD than the lifetime abstainers.

3.3. Association of 12-month drinking volume with CHD

Male very light drinkers were 70% more likely to have CHD than lifetime abstainers (AOR = 1.70, 95% CI = 1.17–2.47) (Table 4). On the other hand, among men, the likelihood of having CHD appeared to decrease with increased drinking volume when very light drinkers served as the reference. Among women, no drinking level was associated with an elevated risk of CHD relative to lifetime abstainers. However, the upper two quartiles of drinkers showed a lower risk of CHD than the lowest quartile of very light drinkers. The quadratic trend was significant for both men and women ($p < 0.001$).

When splitting each quartile into reducers and non-reducers (Table 5), very light and light drinker reducers were 1.5 times to twice more likely to have CHD than lifetime abstainers for both men and women. In contrast, female heavy non-reducer drinkers were 34% less likely to have CHD than lifetime abstainers (AOR = 0.66, 95% CI = 0.47–0.93). The likelihood of CHD was significantly different for reducers and non-reducers (p for contrast < 0.001). Former drinkers were twice more likely to have CHD than lifetime abstainers (AOR = 2.06, 95% CI = 1.43–2.97 for men; AOR = 1.51, 95% CI = 1.19–1.92 for women). Overall, current drinker reducers also were more likely to exhibit CHD than lifetime abstainers (AOR = 1.57, 95% CI = 1.10–2.27 for men; AOR = 1.33, 95% CI = 1.02–1.72) for women). There was virtually no significant difference between former drinkers and current drinker reducers in terms of the risk for CHD (p for contrast = 0.08 for both men and women).

3.4. Association of diagnosed CHD with ever reducing alcohol consumption

Individuals with diagnosed CHD were more likely to have reduced alcohol consumption prior to the past 12 months (men: AOR = 2.08, 95% CI = 1.74–2.48; women: AOR = 1.75, 95% CI = 1.52–2.02) after controlling for demographic covariates.

4. Discussion

This analysis revealed that the risk profiles for current drinker reducers mimics former drinkers toward a greater risk of CHD, while current drinker non-reducers showed neither excess CHD risk nor protective benefits relative to lifetime abstainers. A mixture of reducers and non-reducers in each drinking level may invalidate any attempt of relating alcohol consumption assessed at any single point with health outcomes.

The “healthy drinker” bias existed for both men and women. When we used the lowest quartile of 12-month drinking volume as the reference group among current drinkers, we found the higher drinking quartiles exhibited lower risk of CHD (Table 4). However, when we split each quartile to reducers and non-reducers, it is obvious that the CHD risk profiles among lower-quartile reducers mimics former drinkers. In other words, the increased risk of CHD among lower-quartile reducers was the underlying driving force to artificially produce a relatively lower risk of CHD among higher volume quartiles before splitting was done.

A male heavy drinker during the heaviest drinking period (drinking > 2.3 oz of ethanol per day, which is equivalent to about 5 drinks or more per day) was more likely to have CHD compared to a lifetime abstainer (twice) or a very light drinker (1.5 times). This is in line with the findings from numerous other studies. It is also consistent with epidemiologic evidence linking alcohol consumption with CHD risk factors. Data from 1999 to 2002 National Health and Nutrition Examination Survey (NHANES) indicate that current drinking more than the dietary guidelines (two or more drinks per drinking day for men and one or more drinks per drinking day for women) is associated with an elevated prevalence of multiple CHD risk factors including impaired fasting glucose/diabetes mellitus, hypertriglyceridemia, abdominal obesity, and high blood pressure (Fan et al., 2008b). Another study from NHANES also indicates that drinking volume is directly associated with higher systolic blood pressure in a linear-dependent manner among non-hypertensive current drinkers (Fan et al., 2013). There is no doubt that these alcohol-induced exacerbated risk profiles would accumulate with aging and result in higher tendency of clinical manifestation of CHD.

The lower risk of CHD for female *non-reducer* highest quartile drinkers (almost one drink or more per day) relative to lifetime abstainers should be interpreted with caution. Is this evidence of protective effects of ethanol intake among women? If so, then why did female *reducers* who drank at the same drinking level NOT appear to continue to “benefit” from the ethanol intake? On one hand, the lifetime abstainer group may contain individuals with pre-existing poor health and/or be contaminated with former drinkers or occasional drinkers who might have cut down drinking over time. Data from the National Alcohol Survey in the United States (Rehm et al., 2008) indicates that more than half of those who reported never having a drink of any alcoholic beverage in the 1992 survey reported drinking in previous

surveys (1984, 1990). The contaminated reference group may result in an underestimation of alcohol-attributable morbidity and mortality. Thus, they may not represent the optimal reference group to evaluate the beneficial effects of any current drinking level. On the other hand, it is hard to believe that drinking one drink or more *per day* on average for women would confer any cardioprotection. In fact, epidemiologic studies show opposite evidence. Drinking exceeding one drink *per drinking day* for women has been found to be related to higher prevalence of metabolic syndrome which is a clustering of cardiovascular risk factors (Fan et al., 2008a). Drinking one drink *per day* on average should be even worse. They remain in the highest drinking level before their health profile worsens. With time, the individuals who drank heavily and manifested suboptimal cardiovascular risk profiles may have begun to cut down their alcohol consumption, thus falling into the categories of lower drinking quartiles or abstainers. The pattern for reducers and former drinkers would then ensue. In our study, the current drinker non-reducers initiated drinking at an older age and consumed alcohol for a shorter number of years at a lower level; thus, they may not have accumulated sufficient dosage exposure to manifest chronic clinical outcomes including CHD. If we assume that alcohol consumption may be beneficial to some extent, the worsened CHD profile among current drinker reducers may be attributed to the reduction in alcohol consumption. However, our data rendered evidence that reducers tended to begin drinking the heaviest at a younger age and drink at a larger volume. The concurrent use of tobacco and drugs may be superimposed over excess alcohol consumption to deteriorate their health. Further, their reduced average daily consumption was still higher than that of non-reducers and they did not appear to gain any “benefit” from their constant and relatively higher level of drinking. In fact, they possessed an excess CHD risk comparable to former drinkers even though they were almost ten years younger than former drinkers. Therefore, it makes sense to attribute reducers’ excess CHD risk to accumulated harms caused by heavier drinking earlier in their lives. In accordance with our findings, a large Mendelian randomization analysis based on data from multiple longitudinal studies indicated that individuals with a genetic variant associated with non-drinking and lower alcohol consumption had a more favorable cardiovascular profile and a reduced risk of CHD than those without the genetic variant (Holmes et al., 2014).

This study among U.S. adult populations showed that the heaviest drinking period occurred before 30 years of age and, on average, 12 years before the interview. The average age among individuals with CHD was 55 years. An ideal cohort study evaluating the accumulative health effect of alcohol consumption on CHD should be long in duration and enabled to capture the heaviest drinking period. Unfortunately, a fair amount of cohort studies using CHD morbidity or mortality outcomes may not have fulfilled these criteria. Even in studies where the subjects had been followed up long enough, e.g., the Framingham Heart Study cohort was followed for 24 years, the alcohol consumption pattern was ascertained from a particular exam and that particular exam may not represent the heaviest drinking period or long-term alcohol exposure for an individual (Friedman and Kimball, 1986). This is even more problematic for studies with recurrent cardiovascular events including non-fatal events like CHD as the outcome (Beulens et al., 2010; Gisbertz et al., 2011). In that type of study, it is almost certain that individuals modified their drinking behaviors prior to baseline and kept modifying behaviors during a follow-up period because

they had experienced clinical manifestations of CVD. Reversed causality may underlie the apparent association of moderate alcohol consumption and reduced risk of vascular and all-cause death in these high-risk patients. Exclusion of individuals with alcohol-related health outcomes at baseline (Mukamal et al., 2003) can also contribute to healthy survivor bias. The excluded individuals may comprise those who *have* quit drinking due to adverse cardiovascular health consequences and other competing risks caused by alcohol consumption.

5. Limitations

Limitations are noted. First, drinking status was ascertained by one measurement only. Misclassification is very likely; lifetime abstainers may be contaminated by former drinkers and occasional drinkers (Rehm et al., 2008). We acknowledge this and conducted two sets of regression analysis: lifetime abstainer as the reference group in one set, and lowest drinking level as the reference group in another set. Second, although drinking during the heaviest drinking period may be a better exposure proxy than 12-month drinking when the alcohol–CHD relationship is examined, drinking patterns determined from recall of remote drinking behaviors may not be entirely reliable. Nonetheless, the test–retest reliabilities of usual and largest quantity and overall frequency of drinking were good to excellent for respondent's drinking in the past 12 months or during their heaviest drinking period (Grant et al., 2003; Grant et al., 1995). Third, we include current drinking level (past 12-month drinking) in the analysis mostly for comparison purposes. The results relating past-year drinking to CHD was in distinct contrast with that relating drinking during the heaviest drinking period to CHD. CHD was likely diagnosed before the past 12-month drinking pattern was established. The data also provided evidence that reverse causality might contribute to the apparent protective effects of current drinking—the individuals with diagnosed CHD were more likely to have reduced or stopped drinking prior to the past year. Although most cohort studies would not use 12-month drinking as the baseline, the reverse causality could still underlie most findings in studies where exposure measurement was assessed at a single time point in the past. Nonetheless, current drinking level and drinking level during the heaviest period provided only partial pictures of one's overall ethanol exposure. A more sophisticated study design to obtain lifetime drinking pattern, including robust quantification of accumulative lifetime ethanol exposure, should be adopted (Fan et al., 2006; Fan et al., 2008b). Fourth, the diagnosis of CHD was self-reported. An individual who did not readily have access to the health care system may not have obtained a formal diagnosis even though he/she had CHD. Fifth, we designed the study and analyzed it as a case-control study. Although we carefully designed the study to control for confounding bias, we could not control for other unmeasured potential confounders such as physical activity and dietary preference because we did not collect such information within the time frame appropriate to be included in the current analysis. Sixth, competing risk and selection biases have been frequently cited to be major concerns in observational studies associating alcohol consumption with mortality outcome (Naimi et al., 2017; Zhao et al., 2017). The NESARC-III is a population-based study which recruited U.S. adults based on all age distributions, not just elderly people. We excluded a variety of acute and chronic health conditions known to be related to alcohol consumption from the analysis to reduce bias. However, we were still

unable to include those individuals who died prematurely in association with alcohol consumption. Therefore, our study may not completely avoid potential confounding issues inherent in observational studies. Alternative designs such as Mendelian randomization analyses may shed more light to disentangle the causal relationship between alcohol consumption and health outcomes (Holmes et al., 2014).

6. Conclusion

This study represents the first attempt to categorize 12-month drinkers as reducers and non-reducers, comparing past 12-month drinking with heaviest period of drinking in alcohol–CHD associations. Former drinkers and current drinker reducers demonstrated almost equally worse CHD profiles relative to lifetime abstainers. Past heavy drinking was associated with higher risk of CHD; and apparent “protective” effects of current drinking lost its significance after reverse causality was considered and biological plausibility was disputed. Results indicate alcohol consumption and CHD (possibly other chronic health outcomes) interact and evolve over the life course. Studies that do not consider the constant change of drinking behavior over lifetime may reach false conclusions. The current drinkers who cut down their drinking in the past represent a distinct group who may have drunk heavily in the past with concurrent use of tobacco and/or other drugs. Behavioral and therapeutic interventions could target this group to reduce alcohol and drug use and improve their physical and mental health. Finally, caution is advised for any attempt to promote the cardioprotective effects of alcohol consumption, at any level, in clinical settings and public health practices.

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Appendix A.: Thirty medical conditions screened in the NESARC-III

In Section 14 of the NESARC-III, thirty medical conditions which might be related to alcohol consumption were queried using questions that began with “during the last 12 months, has a doctor or other health professional told you that you had …?” The following conditions were listed: cardiovascular diseases (hardening of the arteries or arteriosclerosis; diabetes or sugar diabetes; high blood pressure or hypertension; high cholesterol; high triglycerides; chest pain or angina; rapid heartbeat or tachycardia; a heart attack or myocardial infarction; any other form of heart condition or heart disease; a stroke; anemia), digestive diseases (cirrhosis of the liver; any other form of liver disease; a stomach ulcer; pancreatitis; bowel problems, like inflammatory bowel disease (IBD) or irritable bowel syndrome (IBS)); sexually transmitted diseases (any sexually transmitted disease or venereal disease like gonorrhea, syphilis, chlamydia, or herpes); respiratory diseases (chronic bronchitis, emphysema, pneumonia, influenza, tuberculosis); malignant neoplasms (liver cancer; breast cancer; cancer of the mouth, tongue, throat, or esophagus; any other cancer);

neurologic conditions (epilepsy or seizure disorder; reflex sympathetic dystrophy (RSD) or complex regional pain syndrome (CRPS); any other nerve problem in your legs, arms, or back; problems falling asleep or staying asleep); musculoskeletal disorders (arthritis, fibromyalgia, osteoporosis).

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Table 1

Characteristics of the study sample by drinking status for men (n = 8950) from the National Epidemiologic Survey on Alcohol and Related Conditions-III, 2012–2013.

Characteristic	Abstainer	Current drinker non-reducer	Current drinker reducer	Former drinker
Sample size	944	4207	2737	1062
Continuous variables, mean (95% CI)				
Age at interview (yr)	36.3 (35.4–37.2)	36.7 (36.2–37.1)	38.8 (38.3–39.4)	47.6 (46.7–48.4)
Age began drinking the most (yr)	–	28.6 (28.4–28.9)	22.5 (22.2–22.9)	21.8 (21.2–22.4)
Average ethanol intake (oz/day) during the heaviest drinking period	–	0.58 (0.55–0.61)	2.52 (2.43–2.62)	1.11 (1.02–1.20)
Average ethanol intake (oz/day) during the past 12 months	–	0.55 (0.52–0.56)	0.68 (0.64–0.71)	–
Categorical variables, %				
Race/ethnicity	33.7	42.6	62.0	49.4
White	30.6	23.0	14.8	21.2
Black	1.1	1.2	1.2	0.9
Native American	8.26	6.3	4.6	5.7
Asian/Pacific Islander	26.4	26.9	17.5	22.7
Hispanic				
Marital status				
Married/cohabiting	37.2	42.2	48.4	52.0
Widowed/separated/divorced	11.1	13.9	17.7	19.9
Never married	51.7	44.0	33.9	28.2
Education				
Less than high school	18.9	15.8	10.0	21.9
High school	35.8	29.8	24.5	31.5
Some college or higher	45.3	54.4	65.6	46.7
Family income				
$0–$19,999	31.6	26.7	20.6	30.3
$20,000–$34,999	23.0	22.1	20.7	23.7
$35,000–$69,999	27.1	28.5	29.2	27.6
≥$70,000	18.3	22.7	29.6	18.4
Urbanicity				

Characteristic	Abstainer	Current drinker non-reducer	Current drinker reducer	Former drinker
Urban	86.7	87.3	84.7	83.1
Rural	13.4	12.7	15.3	17.0
Region				
Northeast	12.1	13.8	14.3	13.8
Midwest	14.7	19.7	25.1	18.3
South	48.6	39.7	32.7	40.7
West	24.6	26.8	28.0	27.2
Tobacco use status				
Current user	12.0	35.7	46.8	28.8
Former user	3.9	8.4	15.2	23.4
Never used	84.1	56.0	38.0	47.8
Lifetime drug use				
Any drug use disorders	1.8	9.2	20.6	11.4
Any non-dependent use of illicit drugs	7.1	30.0	38.6	24.7
Never used illicit drugs	91.1	60.9	40.8	63.9

All differences for categorical variables between drinking status groups are significant at $p < 0.001$.

Table 2

Characteristics of the study sample by drinking status for women (n = 10,350) from the National Epidemiologic Survey on Alcohol and Related Conditions-III, 2012–2013.

Characteristic	Abstainer	Current drinker non-reducer	Current drinker reducer	Former drinker
Sample size	1640	4906	2411	1393
Continuous variables, mean (95% CI)				
Age at interview (yr)	39.9 (39.1–40.6)	37.4 (37.0–37.8)	37.6 (37.0–38.2)	45.7 (44.9–46.4)
Age began drinking the most (yr)	–	29.9 (29.6–30.2)	22.9 (22.5–23.3)	22.7 (22.1–23.2)
Average ethanol intake (oz/day) during the heaviest drinking period	–	0.26 (0.24–0.28)	1.41 (1.36–1.46)	0.40 (0.36–0.44)
Average ethanol intake (oz/day) during the past 12 months	–	0.25 (0.24–0.27)	0.37 (0.35–0.40)	–
Categorical variables, %				
Race/ethnicity	27.8	44.5	64.7	46.2
White	28.8	24.7	13.0	24.6
Black	0.7	1.0	2.0	1.5
Native American	11.7	5.0	3.5	5.2
Asian/Pacific Islander	30.9	24.7	16.8	22.5
Hispanic				
Marital status				
Married/cohabiting	43.9	42.7	48.3	47.7
Widowed/separated/divorced	19.0	21.1	22.4	30.8
Never married	37.1	36.2	29.2	21.5
Education				
Less than high school	23.8	11.7	6.7	19.5
High school	32.1	24.6	18.0	29.0
Some college or higher	44.1	63.7	75.3	51.5
Family income				
$0–$19,999	38.7	29.8	24.3	35.0
$20,000–$34,999	23.8	22.5	19.7	25.8
$35,000–$69,999	22.3	25.6	28.5	22.3
≥ $70,000	15.2	22.0	27.5	17.0
Urbanicity				

Characteristic	Abstainer	Current drinker non-reducer	Current drinker reducer	Former drinker
Urban	84.6	87.2	86.8	81.3
Rural	15.4	12.8	13.2	18.9
Region				
Northeast	12.3	14.1	14.5	13.0
Midwest	16.9	20.1	25.2	17.9
South	47.0	40.5	21.9	44.5
West	23.8	25.3	28.5	24.6
Tobacco use status				
Current user	6.2	21.8	35.5	17.9
Former user	2.3	7.9	15.5	14.5
Never used	91.5	70.3	49.0	67.6
Lifetime drug use				
Any drug use disorders	0.6	5.0	15.2	6.0
Any non-dependent use of illicit drugs	5.4	23.4	40.0	17.5
Never used illicit drugs	94.0	71.6	44.8	76.5

All differences for categorical variables between drinking status groups are significant at $p < 0.001$.

Table 3

Adjusted odds ratios of coronary heart disease and drinking level quartiles during the heaviest drinking period among drinkers by sex from logistic regression models, using lowest quartile and using lifetime abstainers as the reference, respectively, from the National Epidemiologic Survey on Alcohol and Related Conditions-III, 2012–2013.

	Lifetime abstainer	Quartile 1 (very light drinker)	Quartile 2 (light drinker)	Quartile 3 (moderate drinker)	Quartile 4 (heavy drinker)	P for linear trend	P for quadratic trend
Men (n = 8950)							
Average ethanol intake (oz/day)[a]		< 0.131	0.132–0.766	0.767–2.558	> 2.561		
AOR (95% CI)[b]		Ref	0.86 (0.65–1.14)	0.76 (0.57–1.02)	1.54 (1.17–2.01)	0.75	0.014
AOR (95% CI)[c]	Ref	1.39 (0.96–2.01)	1.18 (0.81–1.73)	1.04 (0.71–1.53)	2.09 (1.44–3.03)		
Women (n = 10,350)							
Average ethanol intake (oz/day)[a]		< 0.016	0.017–0.171	0.172–0.882	> 0.883		
AOR (95% CI)[b]		Ref	0.86 (0.67–1.06)	0.86 (0.68–1.08)	0.92 (0.73–1.16)	0.69	0.30
AOR (95% CI)[c]	Ref	1.28 (1.01–1.63)	1.09 (0.84–1.40)	1.10 (0.85–1.43)	1.20 (0.92–1.56)		

Note. Models were adjusted for demographic variables (race/ethnicity, age, marital status, education status, family income, urbanicity, region), tobacco use status, and any lifetime drug use and drug use disorder.

[a]The range of average ethanol intake for each quartile is shown by sex.

[b]Adjusted odds ratios (AOR) and 95% confidence intervals (CI) were obtained by using lowest quartile as the reference group.

[c]Used lifetime abstainers as the reference group in logistic regression models. Average daily ethanol intake from all beverages, based on usual and largest quantities of intake and frequencies of drinking, = 5+ , 8+ , and 12+ drinks.

Table 4

Adjusted odds ratios of coronary heart disease and 12-month drinking level by sex from logistic regression models using lowest quartile and lifetime abstainers as the reference, respectively, from the National Epidemiologic Survey on Alcohol and Related Conditions-III, 2012–2013.

	Quartile 1 (very light drinker)	Quartile 2 (light drinker)	Quartile 3 (moderate drinker)	Quartile 4 (heavy drinker)	P for linear trend	P for quadratic trend
	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)		
Men						
Range of average daily ethanol intake (oz/day)	< 0.053	0.053–0.285	0.286–1.004	> 1.004		
OR (95% CI)[a]	Ref	0.75 (0.56–0.99)	0.51 (0.37–0.69)	0.59 (0.44–0.80)	0.027	< 0.0001
OR (95% CI)[b]	1.70 (1.17–2.47)	1.27 (0.86–1.89)	0.87 (0.58–1.31)	1.01 (0.67–1.51)		
Women						
Range of average daily ethanol intake (oz/day)	< 0.016	0.016–0.084	0.085–0.391	> 0.391		
OR (95% CI)[a]	Ref	0.96 (0.75–1.22)	0.73 (0.56–0.94)	0.65 (0.50–0.85)	0.97	0.0003
OR (95% CI)[b]	1.23 (0.95–1.58)	1.18 (0.90–1.55)	0.90 (0.67–1.20)	0.81 (0.60–1.09)		

Note. Models were adjusted for demographic variables (race/ethnicity, age, marital status, education status, family income, urbanicity, region), tobacco use status, and any lifetime drug use and drug use disorder.

[a]Adjusted odds ratios (AOR) and 95% confidence intervals (CI) were obtained by using the lowest quartile as the reference group;

[b]Using the lifetime abstainers as the reference group. Trend tests were performed among 12-month drinkers only.

Table 5

Adjusted odds ratios of coronary heart disease and 12-month drinking level/status among reducers and non-reducers by sex from the National Epidemiologic Survey on Alcohol and Related Conditions-III, 2012–2013.

	Former drinker	Quartile 1 (very light drinker)	Quartile 2 (light drinker)	Quartile 3 (moderate drinker)	Quartile 4 (heavy drinker)	P for linear trend	P for quadratic trend
		AOR (95% CI)	AOR (95% CI)	AOR (95% CI)	AOR (95% CI)		
Men							
Reducer	2.06 (1.43–2.97)	2.00 (1.31–3.05)	1.65 (1.06–2.59)	1.12 (0.69–1.81)	1.33 (0.85–2.08)	0.76	0.12
Non-reducer		1.46 (0.98–2.19)	0.97 (0.62–1.54)	0.70 (0.43–1.12)	0.78 (0.49–1.23)	0.79	0.08
Women							
Reducer	1.51 (1.19–1.92)	1.55 (1.07–2.26)	1.64 (1.16–2.33)	0.96 (0.65–1.42)	1.06 (0.74–1.51)	0.066	0.034
Non-reducer		1.13 (0.86–1.47)	0.98 (0.73–1.33)	0.87 (0.63–1.21)	0.66 (0.47–0.93)	0.64	0.03

Note. The models were adjusted for race/ethnicity, age, marital status, education status, family income, urbanicity, region, tobacco use status, and any lifetime drug use and drug use disorder. The sex- and quartile-specific ranges are the same as shown in Table 4. Adjusted odds ratios (AOR) and 95% confidence intervals (CI) were obtained by using the lifetime abstainers as the reference group. Trend tests were performed among 12-month drinkers only.