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Lifetime alcohol use patterns and risk of diabetes onset in the National Alcohol Survey

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Abstract

Background: Studies of the role of alcohol use in diabetes risk have rarely included lifetime alcohol use measures, including the frequency of heavy occasions, or evaluated risks among Black or Hispanic respondents in US samples.

Methods: Data from the 2014–15 National Alcohol Survey of the U.S. population were used to estimate diabetes risk from drinking patterns at the time of onset in Cox proportional hazards models in a retrospective cohort design. Models for the population, males and females and for White, Black and Hispanic respondents of both genders were estimated using two versions of drinking pattern groupings at each age.

Results: While a number of significant results were found with the first version of the drinking measures, we focus on those confirmed with measures from responses strictly prior to the age of risk estimation. Compared to the lifetime abstainer group, the 'drinking at least weekly with less than monthly 5+' group had a significantly lower hazard ratio (HR) for the total sample (HR=0.64) and among Whites (HR=0.42). Significantly reduced risks were found in the same models for those who drank 5+ at least monthly but not weekly. No significantly elevated risks were found for either current or prior heavy occasion drinking.

Conclusions: These results are consistent with some prior studies in finding reduced risks for regular light to moderate drinkers, but not consistent with findings from other studies showing increased risk from heavy occasion drinking, particularly among women. New and larger studies with well-defined drinking pattern measures are needed, particularly for US Blacks and Hispanics, to address varying results in this literature.

Keywords

diabetes; lifecourse; drinking pattern; survey

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INTRODUCTION

Studies have shown a reduced risk of diabetes among low-to-moderate alcohol drinkers relative to abstainers and heavy drinkers (Marques-Vidal et al., 2015) or have found significant U-shaped relationships between alcohol and diabetes risk (Koloverou et al., 2015; Polsky and Akturk, 2017). A recent review of alcohol risk relationships for diabetes indicate that while many studies found reduced risk at moderate drinking levels, these benefits appear to be limited to women (Knott et al., 2015). Beneficial effects were also smaller in the relatively few studies with lifetime abstainers (rather than current abstainers) as the control group, including our prior study of the 2005 U.S. National Alcohol Survey (NAS) that found protective effects for diabetes of moderate drinking compared to lifetime abstention (Kerr and Ye, 2010). The risk from heavy drinking has been mixed, potentially due to lack of heavy drinking measures in prior studies (Rehm et al., 2017) or the inconsistent operationalization of heavy drinking in other studies (Greenfield and Martinez, 2017). No differences in diabetes risk across different alcoholic beverage types have been identified (Sluik et al., 2017). Research on the relationship between alcohol and diabetes risk has also been limited to current or previous alcohol use, but the effects of alcohol may accumulate over time or have lagged effects; thus, a lifecourse drinking measure may be needed to capture a potentially more meaningful exposure period.

Given the strong relationship between obesity and diabetes (Mozaffarian et al., 2009), a few studies have considered the potential interplay between excess bodyweight, measured via body mass index (BMI), and alcohol use patterns on diabetes risk. Findings from different countries describe beneficial effects of moderate drinking that were limited to specific BMI groups. Both a recent U.S. study considering all beverage types and a French study focused on wine and diabetes risk found protective effects for overweight women only (Fagherazzi et al., 2014; Kerr et al., 2018); a European case-control study found reduced risk among all overweight respondents (Eckel et al., 2015). Another European study found greater risk reductions among overweight and obese women compared to normal weight women (Beulens et al., 2012), while a study from New Zealand found reduced risk for both genders in the normal weight and overweight groups, but not among the obese (Metcalf et al., 2014). Although these studies vary in the groups considered, and possess methodological limitations, they highlight the important role of BMI for determining diabetes risks based on alcohol use patterns. Specifically, prior studies consistently identified overweight women as a higher risk group, whereas regular light-to-moderate drinking was associated with reduced risk.

Disparities-related research on diabetes has found that U.S. Blacks and Latinos have 50% to 100% higher rates of diabetes than Whites but studies have differed in the sources of these disparities, with some finding that racial/ethnic differences remained even after controlling for risk factors including poverty (Gaskin et al., 2014). Other studies suggest that these racial/ethnic disparities can be attributed to differences in obesity, health behaviors, insurance status, and other socioeconomic measures (LaVeist et al., 2009; Link and McKinlay, 2009). It is unknown whether differences in drinking patterns or susceptibility to the effects of alcohol contribute to racial/ethnic disparities in diabetes as little is known

regarding differential alcohol-risk relationships for diabetes between U.S. racial/ethnic groups, other factors equal.

This study utilizes data from the 2014–15 NAS survey of the U.S. population to estimate diabetes risk in survival models using a retrospective cohort design. Lifecourse drinking and heavy occasion drinking measures are used to characterize drinking at and preceding respondent's onset of diabetes and risks are estimated in relation to lifetime abstainers as the reference group. A second set of analyses utilized these same measures differently, including only drinking information from periods strictly prior to the decade of diabetes onset risk estimation. Models for the population, males and females and for White, Black and Hispanic respondents of both genders were estimated. We control for BMI categories and examine interactions of these with drinking categories, however BMI categories were only measured at the age of interview, a limitation since BMI at the age of diabetes onset is not known. This study may enhance the prior literature on alcohol use and diabetes by evaluating risks of drinking patterns defined by frequencies of moderate and heavy drinking occasions, and by considering the potential role of lagged or accumulated effects of prior heavy drinking.

METHOD

Dataset

The 2014–15 National Alcohol Survey (NAS) was collected between April 2014 and March 2015. The survey involved computer-assisted telephone interviews (CATI) with a representative sample of English- or Spanish-speaking U.S. residents 18 years of age and older conducted by ICF, Inc. The NAS used a dual-frame sampling design that included two-stage, stratified, list-assisted, random digit dial samples of adults from landline telephone households and mobile phone users. Of the completed interviews, about 60% were landline and 40% were mobile. The NAS also included targeted oversamples of geographic areas with high percentages of Black or Hispanic residents. For both landline- and cell-acquired respondents, oversample respondents were offered $20 and other respondents were offered $10 to complete the interview. The Institutional Review Boards of the Public Health Institute, Oakland, CA and ICF, Inc., Fairfax, VA (the fieldwork agency) approved all study protocols. For further information on study design, go to: http://arg.org/center/national-alcohol-surveys/.

The combined cooperation rate (proportion of confirmed eligible people who completed the survey) was 59.8%; the AAPOR (The American Association for Public Opinion Research, 2011) COOP4 rate was somewhat lower: 43.4% (52.0% cell and 38.7% landline). Analysis dividing the sample into randomized groups with varying completion rates found no significant relationship between completion rate and drinking status (Karriker-Jaffe et al., 2017). The total sample of 2014–15 NAS is 7,071, of which 5,632 are complete interviews or partially-completed cases with demographic, alcohol consumption pattern and general health data, the main measures used in the current analysis. Analyses were limited to those aged less than 70 years old at interview (explained below), resulting in an analytic sample of 5,626 cases.

Measures

Lifetime drinking pattern was assessed from a series of questions on drinking during the respondent's teens, 20s, 30s and 40s, beginning with their age of drinking onset. Then for each decade period (between drinking onset and current age), eligible respondents were asked about their frequency of drinking five or more (5+) drinks (14 grams of ethanol) in a day during the specific life decade (Greenfield et al., 2014). For example, for questions on 5+ frequency during the 30s, eligible respondents are those who were 30–39 years old at interview time with an age of drinking onset of 39 or less. The response options were: "every day or nearly every day", "at least once a week", "at least once a month", at least once a year", "less often than that", and "never". Further, for each specific decade, those who answered "at least once a year" or less for the 5+ frequency question were asked "how often you drink alcohol during the teens/20s/30s/40s", with the same response options from "every day or nearly every day" to "never".

Current (last 12 months) alcohol use information was used in one set of measures to derive drinking patterns for years over age 50. Different approaches were taken for respondents aged 50–59 and 60–69. For the 50–59 age group, their drinking pattern during the 50s was based on their current drinking. For the 60–69 age group, we assume that their drinking pattern during the 50s was the same as that of their 40s, while their drinking pattern during the 60s used current drinking pattern. Respondents aged 70 and older were dropped from the all analyses because we believe that neither their current alcohol use nor drinking during their 40s can be used to accurately estimate drinking patterns over the extended period from age 50 to 70 and older. (Drinking was also much less prevalent in the 70+ group with only 36% past-year drinkers) The 12-month 5+ frequency measure was calculated from the graduated frequency series adding the frequencies of having 5–7, 8–11 and 12 or more drinks in a day (Greenfield, 2000). The current drinking information was derived by cross-classifying 12-month 5+ frequency and usual drinking frequency measures, similar to the way described above for the decades measures. Table 1 shows the number of respondents and weighted prevalence in each category for each decade utilizing measures from the first set of estimates.

The lifetime decades measures of the frequency of 5+ and (when infrequent 5+) of any alcohol use described above were then cross-classified to create two sets of lifetime drinking pattern measures separately for each decade with the following categories: 1) 5+ daily/nearly daily, 2) 5+ at least weekly (but less than daily), 3) 5+ at least monthly (but less than weekly), 4) 5+ yearly or less and alcohol at least weekly, 5) 5+ yearly or less and alcohol at least monthly (but less than weekly), 6) 5+ yearly and alcohol less than monthly, 7) No 5+ and alcohol less than monthly, 8) No drinking during the decade, and 9) lifetime abstainer. For the first set of estimates, drinking measures for each decade were used as estimates for all ages in that decade. For the second set of estimates, drinking measures for the prior decade were used for all ages in a specific decade to ensure that exposure estimates were not biased by potential changes in drinking due to diabetes onset. For example, in the second approach, the drinking exposure measure for individuals at age 20s would be their drinking during teens. Similarly, drinking during the respondent's 20s and 30s was used for years when they were in their 30s and 40s, respectively, while drinking during the 40s (the last

measure in the decades drinking series) was used as the exposure measure for years in their 50s and 60s.

Diabetes onset was assessed by the question: “have you ever been told by a doctor or other health professional that you had diabetes?” Those who answered yes were then asked “at what age were you first told?” as a measure of the diabetes onset. While we are unable to distinguish between Type I and Type II diabetes, analyses of onset after age 14 ensures that nearly all of the cases are Type II.

Control variables were mostly time-invariant and measured at the time of the interview, including gender, race/ethnicity, education, family income, employment status and marital status. Current BMI (body mass index) was based on the weight and height of respondents at the time of interview and was coded to underweight (<18.5), normal (18.5–24.9), overweight (25.0–29.9) and obese (≥30) (Centers for Disease Control and Prevention (CDC), 2016). Respondents were also asked whether their mother or father had been “a problem drinker or alcoholic” (parental alcohol problem), and whether they had been physically or sexually abused before age 18. Smoking status was a time-varying measure constructed from questions to lifetime smokers about the age when they first smoked on a regular basis and when they most recently smoked.

Data analysis

Cox proportional hazards models were used to estimate the hazard of diabetes using both the time-varying and time-invariant predictors. A relationship of $h(t) = h0(t) \exp(\boldsymbol{\beta_1 X_1} + \boldsymbol{\beta_2 X_{2t}})$ was assumed, in which h0(t) is the baseline hazard function, $\mathbf{X_1}$ is the vector of time-invariant variables, $\mathbf{X_{2t}}$ is the vector of time-varying variables at time t, and $\exp(\boldsymbol{\beta_1})$ and $\exp(\boldsymbol{\beta_2})$ are vectors of estimated hazard ratios corresponding to $\mathbf{X_1}$ and $\mathbf{X_{2t}}$, respectively. The dataset was structured with each respondent aligned by age, right-censored at either the age of disease onset or, for those who had no disease during their lifetime, the age of interview. This allows for the control of age by design (Korn et al., 1997). The data were also left-censored at age 14, given that the very small number of diabetes cases before that age was presumed to be unrelated to drinking. Analyses were also performed on the sample aged 20–69 (122 individuals aged 18–19 were dropped), using the second set of lifetime drinking measures focused on drinking in the prior available decade to predict diabetes onset. For each set of analyses, the lifetime drinking pattern measures across decades, from teens to 60s, were combined to create the measure of *annual* drinking pattern status at each age, assuming a constant drinking pattern for each decade. Analysis was performed for the total sample and stratified by male and female, and then by White, Black and Hispanic groups, separately.

One key assumption of Cox models is the proportionality of hazards, i.e. hazard ratios of predictive variables do not change with time. Violation of this assumption can lead to model misspecification and failure to uncover the true effect, which may be time-varying. The proportional hazard assumption was tested using Schoenfeld residuals based on the correlation between the scaled Schoenfeld residuals and rank of survival time. The tests have both a covariate-specific form and a global form for all covariates combined (Grambsch and Therneau, 1994; Keele, 2010). Our preliminary analyses utilized sampling weights that

accounted for probability of selection and non-response, and adjusted population distributions based on Census data. Tests of the proportional hazard assumption were highly significant using weighted analysis indicating violations for many of the non-drinking measures. In contrast, when the data were unweighted, very few of these covariates were found to violate the proportionality assumption, suggesting that sampling weights distorted the survival model specifications. We report results based on unweighted analysis, with covariates found to be significant in the Schoenfeld residual tests stratified in the final models. To test the robustness of the findings, we compared the hazard ratio estimates for the drinking measures, our primary focus, between final stratified models from the unweighted and weighted analyses, finding the results to be very similar.

RESULTS

Lifetime drinking patterns by decades (teens, 20s, 30s, 40s, 50s and 60s) are shown in Table 1 for the total sample, aged 18–69. Respondents whose interview age was younger than each specific decade were not included for that decade. Heavy drinking (5+ at least weekly or monthly) peaked during the 20s then dropped with age, while moderate frequent drinking (drinking at least weekly but 5+ yearly or less), and current abstinence, were most prevalent during 50s and 60s. As the number of respondents reporting “5+ daily/nearly daily” was small, these cases were combined with “5+ ≥ once a week” into one category for the survival analysis. Table 1 also shows the proportion of diabetes onset incidence during each decade. Diabetes onset rates increased across decades, with the highest incidence occurring during the 50s and 60s.

Table 2 shows the first sets of estimates of hazard ratios (HR) for drinking patterns and other covariates from the Cox survival models predicting diabetes onset.. Compared to the lifetime abstainer group, the ‘5+ yearly or less and alcohol at least weekly’ group had a significantly lower HR for the total sample (HR=0.47), men (HR=0.51) and women (HR=0.44). Drinking at least monthly (but less than weekly) and 5+ yearly or less was also significantly negatively associated with diabetes onset for women (HR=0.57) and the total sample (HR=0.62), while 5+ at least monthly was found to be significantly protective for men (HR=0.47) and in the total sample (HR=0.56).

The effects of covariates are also shown in Table 2. Racial/ethnic minorities were found to have elevated risk of diabetes compared to Whites, with Black and Hispanic women having significantly higher HRs and Hispanic and other non-Black/Hispanic minority men having elevated risk. Higher education (college graduate or higher) was protective for men and higher income was protective for women. For employment status, significant HR estimates were found for women, with part-time work being protective and unemployed/other status increasing the risk of onset as compared to full-time employment. A higher HR was also observed for former smoking compared to non-smoking among women. Last, being overweight or obese substantially increased risk of diabetes for both men and women.

Table 3 shows HRs of drinking patterns from stratified Cox models for White, Black and Hispanic groups separately. Results for the White group are quite similar to those for the total sample, with the exception that the at least weekly group of heavy occasion 5+ drinking

was also found to be protective. For Blacks, groups drinking at least weekly but less than monthly 5+ and drinking at least monthly but less than monthly 5+ had significantly lower risk for diabetes. None of the drinking pattern categories was found to be significantly predictive of diabetes for Hispanics, however.

With the first set of alcohol measures, we also estimated model specifications considering past heavy drinking and interactions between drinking and excess bodyweight (Results not shown). First, two prior heavy drinking indicators (5+ weekly and 5+ monthly but less than weekly during prior 10 years) were entered into the models to examine potential lagged or accumulated effects of drinking. These measures are comparable across results at different ages, unlike accumulated measures such as years of heavy drinking that are limited at younger ages. No significant relationships were found for the prior heavy drinking measures, suggesting current drinking pattern in a given year to be more influential. Second, interaction terms between drinking patterns and BMI categories were included to evaluate the hypothesis that protective effects of drinking may be more pronounced among overweight individuals. None of these interaction terms were found to be significant.

Results from models utilizing the second set of alcohol measures, where only reports of drinking patterns that were strictly prior, as ages progressed in the risk estimation for the age of diabetes onset are presented in Table 4. Only the alcohol measure results are presented as the results for other variables are very similar to those given in Table 1. Compared to lifetime abstainers, significantly reduced risk of diabetes onset was found for the group drinking at least monthly, but less than weekly and having 5+ days yearly or less often, and for the group drinking 5+ drinks in a day at least monthly but not weekly, in models including the total sample and additionally for White respondents. No other significant effects were found. Generally, compared to the results from the first set of alcohol measures presented in Tables 2 and 3, the HRs increased toward 1 in the groups where significant effects were found. These changes in estimated HRs were particularly notable for Black respondents, for whom the groups showing significantly reduced risk in the Table 3 results no longer show HRs that are close to significant. These changes in results under this more conservative version of the alcohol measures suggest that there may be some bias in the first set of results, due perhaps to the effects of diabetes onset *on* drinking biasing downward the self-report of drinking in that decade.

DISCUSSION

Using data from the 2014–15 NAS and focusing only on results that were confirmed utilizing both sets of alcohol measures this study found reduced risk of diabetes onset for individuals who drink at least weekly with few (less than monthly) or no 5+ occasions, confirming previous findings of protection from regular light to moderate drinking. Results also indicate reduced risk among those with 5+ days monthly but not weekly. This second group of drinkers presumably drinks at lower levels more often, although this cannot be determined from the measures that were reported. In race/ethnicity group specific models, reduced risk for these two groups of drinkers was confirmed for Whites, while no significant effects of alcohol were found for Black or Hispanic respondents. Additional models

investigated potential lagged impacts of prior heavy drinking and interactions between drinking patterns and BMI-defined groups, and no significant effects were found for either.

These results are consistent with reviews of prior studies in finding reduced risk among regular light to moderate drinkers, but do not find increased risk from heavy occasion drinking as has been found in many studies, particularly among women (Rehm et al., 2017). Our results also differ from prior reviews in finding an overall significant protective effect with similar hazard ratios for men and women rather than an effect for women only (Knott et al., 2015). A contribution of these analyses is the finding of no protective effects of regular light to moderate drinking among Black or Hispanic drinkers. This is consistent with our prior study of diabetes onset in a cohort up to age 50 (Kerr et al., 2018). However, that study did find increased risk among Black women who were weekly heavy occasion drinkers, which were not found in the current study. Together, these studies offer the first estimates of diabetes onset risk from alcohol use patterns among Blacks and Hispanics from two different samples and analytic perspectives. Indicators for Hispanic ethnicity and Black race significantly increased diabetes risk by 50% and 31%, respectively, in our overall model, emphasizing the importance of examining modifiable risk factors such as alcohol use in larger studies with appropriate measures of lifecourse drinking, BMI and other risk factors to clarify these relationships.

Our non-significant findings for a BMI and alcohol interaction cannot be strongly interpreted due to the retrospective nature of this study and the inability to capture BMI prior to or within the timeframe of diabetes onset. Individuals' BMI tends to rise over the lifecourse, so that our use of current BMI likely overestimates BMI if onset of diabetes occurred much earlier than the current BMI measure, reducing the accuracy of risk estimates. We chose to estimate the BMI-alcohol interactions despite this significant limitation because few studies have examined this relationship in the U.S. and to follow-up on our prior study findings of significant BMI-alcohol interactions utilizing longitudinal data (Kerr et al., 2018). Further, the use of BMI categories without related information on physical activity and inactivity and diet is a significant limitation (Lahti-Koski et al., 2002). Additional study limitations include the lack of yearly specificity in the decade alcohol measures and, for respondents ages 50–69, the use of earlier decades or current drinking measures to capture their lifecourse drinking. Diabetes onset and lifecourse drinking were also obtained as retrospective self-reports, which may be subject to forgetting, re-interpretation and bias, although the decade alcohol measures have been found to be reliable with prospective indications of validity (Bell and Britton, 2015; Greenfield et al., 2014). Further, while the lifetime abstainer group is the most appropriate reference group, there may be diabetes onset risk factors associated with group that could bias estimates toward finding protective effects of drinking (Kerr et al., 2017; Kerr et al., 2016; Ng Fat et al., 2014). There may also be measurement issues leading to overestimation of lifetime abstention, particularly for older respondents, although most false positives appear to have been very light drinkers (Rehm et al., 2008).

This study adds to the literature on alcohol use and diabetes risk by confirming findings of protective effects of regular light to moderate drinking in a new U.S. general population sample. Furthermore, this study capitalized on NAS data which includes lifecourse alcohol

measures, enabling the use of lifetime abstainers as the control group and the separation of heavy occasion drinkers from those who spread their drinks more evenly, a pattern long recognized as important for longevity (Pearl, 1926). Three versions with different measures of lifecourse patterns of alcohol use were estimated considering the most proximate reports for each age, adding prior heavy drinking frequency to these and, most importantly, focusing on reports that were strictly prior to the age of diabetes onset risk estimation. Comparing the results of these we find that prior heavy drinking does was not a significant predictor and that the most proximate measures appear to be biased toward finding protective effects relative to the models using only strictly prior measures. Importantly, this was the first study to evaluate diabetes onset risk from alcohol use among Black and Hispanic individuals that included older age groups, finding no evidence of the reduced risk found among White drinkers.

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Table 1.

Sample size and weighted percentages for drinking pattern and diabetes onset by decade, National Alcohol Survey 2014–15

Lifecourse Decade	**Teens**		**20s**		**30s**		**40s**		**50s**		**60s**	
Age range of applicable sample	**18–69**		**20–69**		**30–69**		**40–69**		**50–69**		**60–69**	
n	**5,626**		**5,504**		**4,764**		**3,838**		**2,740**		**1,358**	
Drinking pattern	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**	**n**	**%**
5+ Daily/nearly daily	130	2.7	217	4.5	137	3.2	99	2.8	55	2.3	9	0.6
5+ ≥ 1x a week	520	10.7	748	17.3	398	9.1	221	6.3	119	5.5	25	2.0
5+ ≥ 1x a month	555	13.1	810	17.4	543	12.9	300	8.6	133	4.7	17	0.8
5+ <monthly, alcohol ≥ weekly	220	3.8	495	8.0	485	11.2	436	13.3	531	22.7	251	21.2
5+ <monthly, alcohol ≥ monthly	412	7.9	733	12.9	684	14.6	488	12.9	439	16.0	190	14.8
Alcohol yearly or less	930	18.4	1,001	18.8	1,029	22.5	899	24.1	492	17.9	228	15.6
No alcohol during period	1,873	29.6	487	7.2	595	12.5	651	17.6	563	20.2	420	32.4
Lifetime abstainers	835	11.3	781	10.3	684	10.2	559	10.2	396	10.6	209	12.1
Missing	151	2.4	232	3.6	209	3.9	185	4.0	12	0.2	9	0.6
Total	5,526	100	5,504	100	4,764	100	3,838	100	2,740	100	1,358	100
Diabetes onset[1]	30	0.5	60	1.0	123	2.1	200	5.9	240	8.9	106	9.4

[1]The weighted percentage represents incidence proportion of new diabetes onset during the decades among those who never had the disease before

Table 2.

Cox models predicting diabetes onset for adults (ages 18–69) for total sample and separately for men and women

	Total (N=5,505)		Men (N=2,363)		Women (N=3,142)	
	HR	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**
Lifetime drinking (ref Lifetime abstainers)						
No Alcohol this period	0.99	(0.79, 1.25)	1.03	(0.69, 1.54)	0.98	(0.74, 1.31)
No 5+, Freq < monthly	0.98	(0.77, 1.26)	1.08	(0.69, 1.69)	0.95	(0.70, 1.29)
5+ yearly, Freq < monthly	0.94	(0.61, 1.44)	0.82	(0.43, 1.55)	1.13	(0.62, 2.05)
5+ <monthly, Freq ≥ monthly	0.62	(0.46, 0.84) **	0.73	(0.45, 1.18)	0.57	(0.38, 0.86) **
5+ <monthly, Freq ≥ weekly	0.47	(0.33, 0.66) ***	0.51	(0.31, 0.83) **	0.44	(0.26, 0.74) **
5+ ≥ 1x/month	0.56	(0.38, 0.82) **	0.47	(0.27, 0.84) *	0.71	(0.41, 1.22)
5+ ≥ 1x/week	0.79	(0.57, 1.08)	0.80	(0.51, 1.28)	0.85	(0.52, 1.40)
Gender male		(stratified)		NA		NA
Race/ethnicity (ref White)						
Black	1.31	(1.08, 1.58) **	1.32	(0.99, 1.78)	1.36	(1.06, 1.75) *
Hispanic	1.50	(1.22, 1.84) ***	1.65	(1.21, 2.24) **	1.45	(1.10, 1.92) **
Others	1.70	(1.20, 2.40) **	2.16	(1.28, 3.64) **	1.48	(0.93, 2.36)
Education (ref <HS grad)						
High school grad	0.83	(0.66, 1.04)	0.74	(0.51, 1.05)	0.90	(0.67, 1.20)
Some college	0.80	(0.63, 1.02)	0.73	(0.50, 1.07)	0.85	(0.62, 1.16)
College grad/more	0.69	(0.53, 0.90) **	0.61	(0.40, 0.92) *	0.76	(0.54, 1.09)
Family income (ref < $20k)						
$20–39,999k	0.91	(0.73, 1.13)	1.18	(0.83, 1.69)	0.73	(0.54, 0.98) *
$40–79,999k	0.86	(0.69, 1.09)	1.03	(0.71, 1.49)	0.75	(0.55, 1.01)
At least $80k	0.69	(0.51, 0.93) *	0.94	(0.60, 1.48)	0.50	(0.32, 0.77) **
Missing	0.66	(0.51, 0.86) **	0.72	(0.45, 1.16)	0.62	(0.45, 0.85) **
Employment (ref Full-time)						
Part-time	0.73	(0.54, 1.00) *	0.99	(0.64, 1.52)	0.56	(0.36, 0.87) **
Retired	1.13	(0.91, 1.40)	1.12	(0.83, 1.53)	1.11	(0.82, 1.51)

	Total (N=5,505)		Men (N=2,363)		Women (N=3,142)	
	HR	95% CI	HR	95% CI	HR	95% CI
Unemployed/others	1.31	(1.06, 1.62)*	1.10	(0.78, 1.54)	1.41	(1.07, 1.87)*
Marital status (ref Married)						
Separate/Divorce/Widowed	0.91	(0.76, 1.08)	1.02	(0.76, 1.37)	0.83	(0.66, 1.04)
Never married	0.95	(0.76, 1.18)	1.23	(0.89, 1.71)	0.80	(0.59, 1.08)
Smoking (ref Never smoke)						
Current Smoker	1.09	(0.90, 1.32)	1.14	(0.85, 1.52)	1.02	(0.78, 1.33)
Ex-smoker	1.17	(0.92, 1.50)	0.87	(0.59, 1.28)	1.50	(1.09, 2.07)*
Body Mass Index (ref Normal)						
Underweight (BMI < 18.5)	1.64	(0.59, 4.53)	2.24	(0.51, 9.87)	1.28	(0.31, 5.36)
Overweight (25 ≤ BMI < 30)	2.07	(1.55, 2.77)***	2.49	(1.57, 3.95)***	1.77	(1.21, 2.60)**
Obese (BMI ≥ 30)	3.40	(2.59, 4.48)***	4.41	(2.81, 6.91)***	2.83	(1.99, 4.01)***
Missing	2.64	(1.80, 3.86)***	2.28	(0.98, 5.34)	2.56	(1.65, 3.99)***
Parental alcohol problem	1.12	(0.92, 1.36)	1.30	(0.95, 1.78)	1.02	(0.79, 1.32)
Childhood physical abuse	0.95	(0.77, 1.17)	0.84	(0.61, 1.15)	1.01	(0.75, 1.36)
Childhood sexual abuse	1.21	(0.94, 1.55)	1.10	(0.64, 1.92)	1.25	(0.94, 1.67)

*HR=hazard ratio; CI=confidence intervals; p<0.05,

**p<0.01,

***p<0.001

Table 3.

Stratified Cox models predicting diabetes onset from drinking pattern for adults (ages 18–69) by race/ethnicity[1]

	White (N=2,435)		Black (N=1,375)		Hispanics (N=1,403)	
Lifetime drinking (ref lifetime abstainers)	**HR**	**95% CI**	**HR**	**95% CI**	**HR**	**95% CI**
No Alcohol this period	0.87	(0.57, 1.32)	0.79	(0.52, 1.19)	1.07	(0.71, 1.62)
No 5+, Freq < monthly	0.80	(0.51, 1.24)	0.90	(0.58, 1.40)	1.13	(0.73, 1.77)
5+ yearly, Freq < monthly	0.97	(0.52, 1.80)	0.37	(0.09, 1.54)	0.80	(0.35, 1.84)
5+ <monthly, Freq ≥ monthly	0.53	(0.32, 0.89)*	0.56	(0.33, 0.95)*	0.71	(0.40, 1.28)
5+ <monthly, Freq ≥ weekly	0.38	(0.22, 0.66)***	0.52	(0.29, 0.93)*	0.51	(0.23, 1.13)
5+ ≥ 1x/month	0.37	(0.19, 0.72)**	0.58	(0.27, 1.22)	0.61	(0.30, 1.23)
5+ ≥ 1x/week	0.52	(0.29, 0.94)*	0.60	(0.34, 1.07)	1.10	(0.63, 1.91)

[1]Controlling for age, gender, education, income, employment status, marital status, smoking, BMI, parental alcohol problem, childhood physical abuse and childhood sexual abuse

HR=hazard ratio; CI=confidence intervals;

*p<0.05,

**p<0.01,

***p<0.001

Table 4.

Second set of analyses utilizing measures of drinking strictly prior to the decade of onset risk assessment in Cox models predicting diabetes onset among respondents aged 20–69[1]

	Total		Men		Women	
(Ref: life abstainers)	**HR**	**CI**	**HR**	**CI**	**HR**	**CI**
No Alcohol this period	0.95	(0.74, 1.21)	0.80	(0.51, 1.25)	1.04	(0.77, 1.41)
No 5+, Freq < monthly	0.95	(0.73, 1.23)	1.21	(0.75, 1.94)	0.86	(0.62, 1.19)
5+ yearly, Freq < monthly	0.90	(0.61, 1.33)	0.85	(0.48, 1.49)	0.88	(0.48, 1.60)
5+ <monthly, Freq ≥ monthly	0.80	(0.59, 1.09)	0.75	(0.44, 1.27)	0.88	(0.60, 1.29)
5+ <monthly, Freq ≥ weekly	0.64	(0.44, 0.91)*	0.70	(0.41, 1.18)	0.59	(0.35, 1.01)
5+ ≥ 1x/month	0.64	(0.45, 0.90)*	0.63	(0.38, 1.04)	0.67	(0.41, 1.12)
5+ ≥ 1x/week	0.87	(0.64, 1.16)	0.91	(0.59, 1.41)	0.87	(0.55, 1.38)

	White		Black		Hispanics	
(Ref: life abstainers)	**HR**	**CI**	**HR**	**CI**	**HR**	**CI**
No Alcohol this period	0.82	(0.52, 1.29)	0.71	(0.45, 1.13)	1.02	(0.66, 1.59)
No 5+, Freq < monthly	0.83	(0.52, 1.31)	0.79	(0.49, 1.28)	1.15	(0.72, 1.85)
5+ yearly, Freq < monthly	0.62	(0.33, 1.17)	0.83	(0.32, 2.16)	1.18	(0.59, 2.33)
5+ <monthly, Freq ≥ monthly	0.68	(0.41, 1.13)	0.76	(0.44, 1.31)	0.82	(0.45, 1.49)
5+ <monthly, Freq ≥ weekly	0.42	(0.22, 0.79)**	0.77	(0.43, 1.38)	0.83	(0.38, 1.84)
5+ ≥ 1x/month	0.45	(0.25, 0.80)**	0.82	(0.43, 1.57)	0.67	(0.35, 1.28)
5+ ≥ 1x/week	0.64	(0.39, 1.07)	0.77	(0.45, 1.34)	1.04	(0.60, 1.79)

[1]Controlling for age, gender, education, income, employment status, marital status, smoking, BMI, parental alcohol problem, childhood physical abuse and childhood sexual abuse

HR=hazard ratio; CI=confidence interval;

*p<0.05,

**p<0.01