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## Lifetime Alcohol Use & Cognitive Performance in Older Adults

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### Abstract

**Background**—Substance use is an important clinical issue in the older adult population. As older adults are susceptible to cognitive disorders, the intersection of the fields of substance use and cognitive neuroscience is an active area of research. Prior studies of alcohol use and cognitive performance are mixed, and inconsistencies may be due to under- or over-adjustment for confounders.

**Aim**—This manuscript adds to this literature by conducting a secondary analysis of self-reported lifetime history of alcohol use and cognitive performance in older adults ( $n = 133$ ). We hypothesized that current alcohol users would have poorer cognitive performance compared to never/minimal and former alcohol users.

**Methods**—Older adult participants were classified into never/minimal alcohol users, former alcohol users, and current alcohol users. A neurocognitive battery included a global cognitive measure and individual measures of attention, memory, fluency, and executive function. A directed acyclic graph (DAG)-based approach was used to select variables to be included in the multiple linear regression models.

**Results**—Though unadjusted analyses showed some significant associations between alcohol use and cognitive performance, all associations between alcohol use and cognitive performance were eliminated after adjusting for age, education, sex, race and smoking pack years. Alcohol drink years were not significantly associated with cognitive performance among current and former alcohol users.

**Discussion**—These results suggest that lifetime alcohol use is not significantly associated with cognitive performance in older adults after adjustment for key confounders. Inconsistencies in

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prior studies may be due to uncontrolled confounding and/or unnecessary adjustment of mediators and/or colliders.

### Keywords

alcohol; substance use; cognition; cognitive; older adult

## INTRODUCTION

Substance use is an important clinical issue in the older adult population<sup>1–8</sup>. The fields of substance use and geriatrics intersect in many areas (conceptual model depicted in Figure 1; draw.io, Jgraph, version 5.5.6.0), such as drug-medication interactions<sup>9</sup>, substance-induced medical complications<sup>10</sup>, age-specific substance use treatments<sup>11</sup>, and psychiatric comorbidities<sup>12</sup>. Another key intersection of these fields is in the domain of cognition. As older adults are susceptible to cognitive disorders, the intersection of the fields of substance use and cognitive neuroscience is an active area of research<sup>13–19</sup>. The general consensus is that based on the effects of aging and substance use on cognitive ability<sup>20</sup>, there is a significant potential for cognitive ability to be affected among older adults who use substances compared to those who do not. Because the process of aging itself can negatively affect neurotransmitter systems and drug metabolism, substance use can increase drug-related complications in older adults<sup>20</sup>.

This manuscript specifically focuses on alcohol use and cognitive performance in older adults. The research evidence of the association between alcohol use and cognitive performance in this population is mixed. Some reasons for the differences among studies include length of follow-up, how alcohol use is defined, which cognitive measures are used, sociodemographics and under- or over-adjustment for confounders. Some studies have shown that alcohol use is associated with either increased cognitive impairment<sup>21</sup> or decreased cognitive impairment<sup>22</sup>. Other studies have shown that current alcohol users have better cognitive performance than former alcohol users or those who have never used alcohol<sup>23–28</sup>. Whether alcohol affects cognitive performance also depends on many other factors, such as sex<sup>29–34</sup>, dose of alcohol<sup>35–39</sup> and length of abstinence<sup>40</sup>.

Most prior studies have focused on current alcohol use only and have not considered the full history of alcohol use and, in particular, have not differentiated between lifelong abstainers and former drinkers. Since there is no definitive consensus on the effects of social/non-hazardous alcohol use on cognitive performance in older adults, this manuscript adds to this literature by conducting a secondary analysis of self-reported lifetime history of alcohol use and cognitive performance in older adults using baseline data from the Mental Activity and eExercise (MAX) trial. We hypothesized that current alcohol users would have poorer cognitive performance compared to never/minimal and former alcohol users. We also hypothesized there would be a dose-dependent effect of alcohol use, such that increasing alcohol use over the lifetime would be associated with worse cognitive performance in late life. We used a directed acyclic graph (DAG)-based approach<sup>41</sup> to select confounders to include in statistical models.

## METHODS

### Study Setting

Details of the original study have been published elsewhere<sup>42</sup>. The institutional review boards at the University of California, San Francisco, and the San Francisco Veterans Affairs Medical Center approved this study. All participants provided written informed consent. Participants were recruited through direct mailing to the neighborhoods adjacent to the study site, in addition to advertisements, flyers, physician and friend referrals, and recruitment databases.

Inclusion criteria included being age 65 years or older, having a cognitive complaint (answering yes to the question “Do you feel that your memory or thinking skills have gotten worse recently?”), fluency in the English language, and not planning to travel for more than 1 week during the study period. Study participants with any history of an alcohol use disorder or heavy drinking (defined as 5 drinks/day for 5 days in a row OR 5 days/month) or a history of a substance use disorder or heavy drug use (defined as daily usage for 5 days in a row OR 5 days/month) were excluded. Other exclusion criteria included dementia (based on self-report, physician diagnosis, or scoring 18 or less on the modified Telephone Interview for Cognitive Status<sup>43</sup>), other neurological or major psychiatric disorders, limited life expectancy, or other factors that could limit ability to participate fully in the intervention.

### Measures

Sociodemographic (e.g., age, race, income, occupation), medical (e.g., cardiovascular, diabetes), psychiatric (e.g., depression, sleep), alcohol, and smoking (e.g., never/former/current, pack-years) variables were collected through self-report. Sleep quality was assessed using seven questions from the Sleep Disorders Questionnaire on the 2005 to 2006 National Health and Nutrition Examination Survey (range 0–28, where higher scores reflect worse sleep quality)<sup>44</sup>. Depression was assessed using the Geriatric Depression Scale<sup>45</sup>. Study participants were asked at the baseline visit if they had more than 100 drinks in their lifetime. If yes, they were asked if they had any alcohol in the past 30 days, how old they were when they started drinking, how old they were when they had their most recent drink, the average number of drinks per day consumed when they drank, and the types of alcohol usually consumed (wine, beer or hard liquor).

We classified participants into 3 groups of alcohol use: never/minimal users (< 100 drinks in lifetime), former users (>100 drinks in lifetime and no alcohol in past 30 days), and current users (>100 drinks in lifetime and alcohol in past 30 days). The rationale for this classification scheme was based on categories that are used for smoking, which define “never smokers” as an adult who has never smoked, or who has smoked <100 cigarettes in his/her lifetime<sup>46</sup>; we categorized those who used 100 drinks in lifetime as never/minimal. “Never/minimal” users in this study were not actively consuming alcohol. We also calculated the total number of “drink-years” over the lifetime as the age when they last drank minus the age when they first drank multiplied by the average drinks/day when consuming alcohol. Similar questions and procedures were used to determine lifetime smoking history,

including definitions of non-smokers, former smokers, current smokers and lifetime pack-years consumed.

A detailed neurocognitive battery included the Modified Mini-Mental State examination (3MS) to assess global cognitive status (range, 0–100), and individual measures of attention, memory, fluency, and executive function. Specific measures were selected because they have good validity and reliability and are sensitive to cognitive decline in older adults. Measures included were verbal learning and memory (Rey Auditory Verbal Learning Test [RAVLT]), verbal fluency (letter and category), processing speed (Digit Symbol Substitution Test, Trail-Making Test part A [Trails A]), executive function/mental flexibility (Trail-Making Test part B [Trails B]), executive function/inhibition (Eriksen Flanker Test [EFT], congruent and incongruent reaction times), visuospatial function (Useful Field of View [UFOV]), processing speed, divided attention, and selective attention). Z-scores were based on raw score transformations ( $[\text{raw score} - \text{mean score}] / \text{standard deviation}$ ). A composite score for the neurocognitive measures was also calculated as previously described<sup>42</sup>. The current alcohol users group served as the standardization reference.

### Statistical Analysis

We estimated and tested all statistical models using Stata/SE version 14.1 (College Station, TX; update level 7/20/2016). Parametric and non-parametric analyses were used as appropriate. When comparing alcohol use categories for baseline sociodemographic and clinical data, ANOVA was used for continuous variables, and Pearson's chi-square or Fisher's exact test were used for categorical variables. We initially considered  $p$  values  $< 0.05$  as statistically significant. However, we used the False Discovery Rate (FDR) method in Stata/SE version 14.1 (author Roger Newson, King's College, London, UK) for multiple comparison correction of any significant analyses; specifically, we tried the liu1, liu2, simes, yekutieli, and krieger methods with the smileplot option.

We conducted both unadjusted and adjusted analyses. Traditional methods of adjusting for confounding may miss or even introduce biases such as selection bias and collider bias, which can be minimized by using more modern graphical methods of adjustment<sup>47</sup>. We used a directed acyclic graph (DAG)-based approach to select the variables to be included in the regression models<sup>41, 47</sup>. Our DAG is drawn in Figure 2 using the website <http://dagitty.net><sup>48</sup>. The DAG-based approach allows for a graphical representation of causal effects among variables. Causation is indicated by an arrow that connects two variables. If there is no direct causal association between two variables, then the two variables are left unconnected. A DAG is called acyclic because no ordered sequence of arrows leads back to the variable from where the sequence began<sup>49</sup>. A confounding variable has arrows that are directed away from the variable, and adjusting for such variables closes the backdoor pathways between the primary predictor of interest (i.e., alcohol use) and the primary outcome of interest (i.e., cognitive performance)<sup>49</sup>.

We conceptualized age, education, sex, race, socioeconomic status (i.e., income and occupation), and smoking to confound the association between alcohol use and cognitive performance; most of these variables were adjusted for in the regression models (see Results section for further comments on income and occupation). Whereas, we conceptualized

medical problems (e.g., heart problems, diabetes), poor sleep and depression to partially mediate the association between alcohol use and cognitive performance; mediators were not adjusted for in the regression models, since adjustment for mediators would decrease the total effect of alcohol use on cognitive performance. When comparing alcohol use categories for cognitive performance data, multiple linear regression was used for all analyses.

Regression models were checked for normality, constant variance (homoscedasticity), outlying/high leverage/influential points and multicollinearity. Normality was assessed using Q-Q plots and kernel density plots of the residuals. Constant variance assessed by residual versus predictor (RVP) plots of continuous predictors and residual versus fitted (RVF) plots. Outlying/high leverage/influential points were assessed using boxplots to detect outlying values among the  $\beta$ s. Multicollinearity was assessed analyzing the variance inflation factor values after each regression model. Normality, constant variance and a lack of multicollinearity were met for nearly all models (except as noted in the Results section), and no outlying/high leverage/influential points were found. When the primary predictor was continuous (e.g., alcohol drink years), linearity was also assessed using component plus residual (CPR) plots with the LOWESS smooth option. Linearity was met for nearly all models (except as noted in the Results section).

## RESULTS

Table 1 presents baseline sociodemographic and clinical data by alcohol use categories (from  $n = 133$ : never/minimal 18.8%, former 17.3%, and current 63.9%). Current alcohol users had the highest level of education (mean 16.7 years, SD 2.1,  $p = 0.02$ ) and were more likely to be non-Hispanic Caucasian ( $\chi^2(2) = 16.1$ ,  $p < 0.001$ ) and smokers (Fisher's exact,  $p < 0.001$ ). Never/minimal alcohol users were more likely to be female ( $\chi^2(2) = 6.0$ ,  $p = 0.049$ ). The three groups did not significantly differ on any other variables.

Table 2 presents cognitive performance data by alcohol use categories. In unadjusted analyses, never/minimal alcohol users significantly scored more poorly than current alcohol users on the 3MS (coefficient  $-3.55$ , 95% CI  $-5.57$  to  $-1.53$ ,  $p = 0.001$ ) and the RAVLT total words learned (coefficient  $-0.62$ , 95% CI  $-1.05$  to  $-0.17$ ,  $p = 0.007$ ); never/minimal alcohol users significantly scored higher on the Useful Field of View divided attention (which means worse performance) than current alcohol users (coefficient  $0.64$ , 95% CI  $0.18$  to  $1.09$ ,  $p = 0.006$ ); former alcohol users significantly scored more poorly than current alcohol users on verbal (letter) fluency (coefficient  $-0.57$ , 95% CI  $-1.03$  to  $-0.11$ ,  $p = 0.015$ ). The above unadjusted analyses remained significant even after trying various FDR multiple comparison correction methods (lowest overall critical  $p$ -value = 0.0167 with the yekutieli method). Adjusted analyses were controlled for age, education, sex, race and smoking pack years; the three groups did not significantly differ on any cognitive variables.

Table 3 presents cognitive performance data by alcohol drink years. For former users, the mean number of drink years was 27.3 (standard deviation 44.7, range 2 to 198). For current users, the mean number of drink years was 35.5 (standard deviation 35.4, range 4 to 192). In unadjusted analyses, drink years was significantly associated with verbal (letter) fluency in current alcohol users (coefficient 0.006, 95% CI 0.0004 to 0.012,  $p = 0.036$ ), and drink years

was significantly associated with Useful Field of View divided attention in former alcohol users (coefficient 0.012, 95% CI 0.0009 to 0.023,  $p = 0.035$ ). The above unadjusted analyses remained significant even after trying various FDR multiple comparison correction methods (lowest overall critical  $p$ -value = 0.0476 with the kriegler method). Adjusted analyses were again controlled for age, education, sex, race and smoking pack years; the three groups again did not significantly differ on any cognitive variables.

For the Useful Field of View processing z-score in Tables 2 and 3, the Q-Q plot and kernel density plot of the residuals showed a skewed distribution; a bootstrapping procedure using percentile-based confidence intervals (1000 replications specified) did not significantly change the coefficient estimates. For the 3MS total score, Composite z-score at baseline, Verbal (letter) fluency z-score, Category fluency z-score, RAVLT delayed recall z-score, RAVLT total words learned z-score, Digit Symbol Substitution z-score, Trails A z-score, Eriksen Flanker congruent z-score, Eriksen Flanker incongruent z-score, and Useful Field of View processing z-score in Table 3, the CPR plots appeared to show a slight departure from linearity. Restricted cubic splines were created, but statistically significant departures from linearity were not found.

Regarding confounding variables, smoking was alternatively controlled for as a categorical variable (never/former/current). However, whether smoking was included continuously as pack years or categorically as never/former/current made no significant difference in any adjusted analysis; we kept smoking as a continuous variable in all adjusted analyses. Regarding income and occupation, though we initially conceptualized these to be confounding variables, income and occupation caused multicollinearity issues (variance inflation factor values  $> 10$ ; tolerance values  $< 0.1$ ) in some analyses in Table 3. Whether we included or excluded income and occupation made no significant difference in any adjusted analysis; we removed these variables from all adjusted analyses in Tables 2 and 3. Regarding education, education could be viewed as a mediator for early-life cognitive ability<sup>50</sup> instead of a confounding variable; however, whether we included or excluded education made no significant difference in any adjusted analysis (after correcting for multiple comparisons). We kept education in the final adjusted analyses in order to stay consistent with publications that use some of the same neurocognitive tests used in this study and adjust for education (e.g., Trails A and B<sup>51</sup>).

## DISCUSSION

In this secondary analysis of older adults, we found that never/minimal alcohol users, former alcohol users, and current alcohol users did not significantly differ on any cognitive performance measures after adjusting for age, education, sex, race and smoking pack years. The number of alcohol drink years was not significantly associated with cognitive performance among current alcohol users and former alcohol users.

Interestingly, the unadjusted analyses showed some significant associations between different types of alcohol use and cognitive performance. Never/minimal alcohol users performed worse on some cognitive measures compared to current alcohol users. These unadjusted associations show that this dataset had enough power to detect significant



associations. These unadjusted associations are also consistent with several prior studies that showed worse cognitive performance among those who do not drink alcohol or have stopped drinking alcohol (e.g.,<sup>23–26, 28, 30, 31, 39</sup>), compared to those who currently drink alcohol. However, these unadjusted associations were eliminated after controlling for the variables that we presented in Figure 2. This shows the importance of carefully adjusting for confounders and not adjusting for mediators or colliders in analyses by using a more modern graphical method of adjustment, such as a DAG-based approach. Significant associations between alcohol use and cognitive performance in previous studies may have been due to uncontrolled confounding and/or unnecessary adjustment of mediators and/or colliders.

This manuscript has several strengths. First, a detailed neurocognitive battery allowed for the analysis of various cognitive domains. Second, while the DAG-based approach is by no means the definitive approach to variable selection in a regression model, and other clinical researchers might differently conceptualize the variables that we included in the regression models, we used this approach as a reference with which to compare future publications on this topic. Other approaches for variable selection include, but are not limited to, forward selection, backward selection, and stepwise selection<sup>49</sup>. By using a DAG, at minimum, our goal was to avoid including colliders (which can falsely induce an association) or mediators (which can ameliorate an association) in the regression models<sup>49</sup>. To our knowledge, a DAG-based approach to variable selection has not been previously used in the literature of alcohol use and cognitive performance in older adults. Previous studies that have not used a DAG-based approach may have unknowingly included colliders or mediators, and this may contribute to inconsistency in the literature. Third, we were able to capture a lifetime history of alcohol use with the metric of alcohol drink years. Finally, we analyzed the cognitive data not only by alcohol use categories, but we were able to assess dose response by analyzing alcohol drink years.

This manuscript undoubtedly has limitations. First, the research questions asked in this secondary analysis were not considered when the study was originally designed. In addition, the participants recruited were generally higher educated, and this may limit external generalizability to groups with lower education. Second, for an observational study, the sample size is small. Though violations of regression model assumptions were checked, the significantly smaller number of never/minimal and former drinkers will still be more susceptible to sampling error. A larger sample size would also allow for more advanced statistical modeling techniques, such as latent variable modeling for the neurocognitive measures or structural equation modeling. A larger sample, which would result in larger statistical power, might have also allowed the discovery of some significant associations between alcohol use and cognitive performance. Third, due to the small sample size, the regression models did not explicitly examine for interactions among the predictors. There may have been interactions that served as significant moderators. Finally, while this sample is unlikely to have other substance use, urine toxicology may have helped confirm a lack of other substance use during the study period.

## CONCLUSIONS

In summary, this secondary analysis of older adults found that alcohol use was not associated with cognitive performance after adjustment for key confounders using a DAG-based approach. Future directions include larger sample sizes to examine smaller effect sizes, including individuals with alcohol use disorders, selecting different variables based on an updated DAG, conducting other variable selection procedures and confirming lack of other substance use with urine toxicology.

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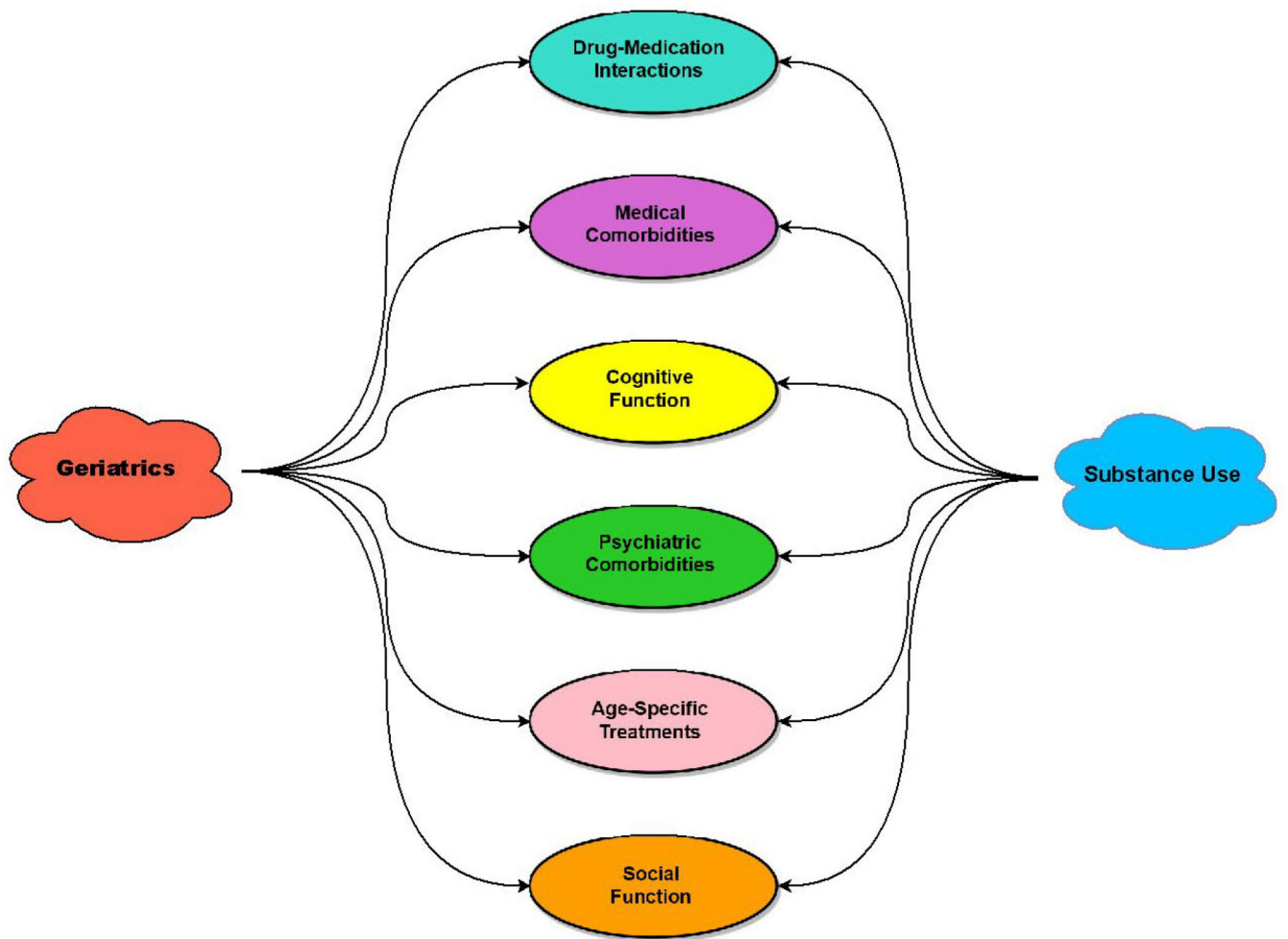
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**Figure 1.**  
Conceptual Model – Intersection of the Fields of Geriatrics and Substance Use.



**Figure 2.**  
 Directed Acyclic Graph Approach to Variable Selection for Regression Models.  
 Alcohol use = predictor; Cognitive performance = outcome; red circles are covariates; blue circles are mediators

**Table 1**

Baseline Sociodemographic and Clinical Data by Alcohol Use Categories.

	Never/ Minimal <i>n</i> = 25	Former <i>n</i> = 23	Current <i>n</i> = 85	Test Statistic and Significance
	Unadjusted Mean (S.D. <sup>a</sup> ) or %			
Age (years)	74.1 (6.4)	72.4 (5.6)	73.3 (6.0)	$F(2, 130) = 0.47, p = 0.62$
Education (years)	15.4 (3.0)	15.8 (2.2)	16.7 (2.1) <i>n</i> = 83	$F(2, 128) = 4.0, p = 0.02$
Female	84%	52.2%	61.2%	$\chi^2(2) = 6.0, p = 0.049$
Non-Hispanic Caucasian	36%	56.5%	77.8%	$\chi^2(2) = 16.1, p < 0.001$
Income – \$20,000 and under	20%	4.4%	10.6%	Fisher's exact = 0.74
Occupation – Management or Professional	48%	52.2%	58.8%	Fisher's exact = 0.43
Hypertension	64%	43.5%	54.1%	$\chi^2(2) = 2.0, p = 0.36$
Congestive Heart Failure	0%	4.4%	1.2%	Fisher's exact = 0.35
Heart Attack	1.9%	1.7%	6.4%	Fisher's exact = 0.71
Diabetes	3.8%	3.5%	12.8%	$\chi^2(2) = 0.61, p = 0.74$
Total Sleep Score	7.4 (6.3)	8.2 (5.9)	8.5 (5.3)	$F(2, 130) = 0.38, p = 0.68$
Geriatric Depression Scale – total score	1.6 (1.2)	2.0 (1.7)	1.7 (1.6)	$F(2, 130) = 0.31, p = 0.74$
Never Smoker	88%	52.2%	35.7% <i>n</i> = 84	Fisher's exact < 0.001
Former Smoker	12%	34.8%	60.7% <i>n</i> = 84	
Current Smoker	0%	13%	3.6% <i>n</i> = 84	
Smoking Pack Years	5.4 (17.9)	17.3 (28.6) <i>n</i> = 22	15.0 (25.2) <i>n</i> = 82	$F(2, 126) = 1.8, p = 0.17$

<sup>a</sup>: S.D. = standard deviation

Table 2

Cognitive Performance Data by Alcohol Use Categories.

	Never/ Minimal <i>n</i> = 25	Former <i>n</i> = 23	Current <i>n</i> = 85	Adjusted Coefficient <sup>a</sup> for comparator group (standard error), Significance and Standardized Beta
	Unadjusted Mean (S.D.)			
3MS total score	91.8 (6.63)	95.8 (3.50)	95.4 (3.92)	Never/Minimal: -1.60 (1.11), <i>p</i> = 0.14, $\beta$ = -0.13 Former: 1.17 (1.02), <i>p</i> = 0.26, $\beta$ = 0.09
Composite z score at baseline	0.02 (0.24) <i>n</i> = 23	-0.02 (0.27) <i>n</i> = 22	0.003 (0.31) <i>n</i> = 77	Never/Minimal: 0.07 (0.07), <i>p</i> = 0.30, $\beta$ = 0.11 Former: 0.06 (0.07), <i>p</i> = 0.41, $\beta$ = 0.08
Verbal (letter) fluency z-score	-0.13 (1.08)	-0.40 (0.87)	0.18 (0.99)	Never/Minimal: 0.15 (0.24), <i>p</i> = 0.52, $\beta$ = 0.06 Former: -0.27 (0.23), <i>p</i> = 0.24, $\beta$ = -0.10
Category fluency z-score	-0.20 (1.24)	-0.10 (0.91)	0.07 (0.95)	Never/Minimal: 0.08 (0.23), <i>p</i> = 0.72, $\beta$ = 0.03 Former: -0.005 (0.23), <i>p</i> = 0.98, $\beta$ = -0.002
RAVLT delayed recall z-score	-0.13 (0.95)	0.16 (0.83)	0.06 (1.03) <i>n</i> = 83	Never/Minimal: -0.004 (0.22), <i>p</i> = 0.99, $\beta$ = -0.02 Former: 0.24 (0.22), <i>p</i> = 0.27, $\beta$ = 0.10
RAVLT total words learned z-score	-0.48 (1.07)	0.23 (0.87)	0.12 (0.98) <i>n</i> = 83	Never/Minimal: -0.27 (0.21), <i>p</i> = 0.21, $\beta$ = -0.11 Former: 0.27 (0.20), <i>p</i> = 0.18, $\beta$ = 0.10
Digit Symbol Substitution z-score	0.03 (1.08)	0.01 (1.08)	0.02 (0.97) <i>n</i> = 83	Never/Minimal: 0.23 (0.24), <i>p</i> = 0.34, $\beta$ = 0.09 Former: 0.15 (0.23), <i>p</i> = 0.52, $\beta$ = 0.06
Trails A z-score	0.11 (1.03)	0.06 (0.90) <i>n</i> = 22	-0.06 (1.02) <i>n</i> = 82	Never/Minimal: -0.06 (0.24), <i>p</i> = 0.82, $\beta$ = -0.02 Former: 0.002 (0.24), <i>p</i> = 0.99, $\beta$ = 0.001
Trails B z-score	0.32 (1.23)	0.13 (1.16)	-0.12 (0.88) <i>n</i> = 83	Never/Minimal: 0.11 (0.24), <i>p</i> = 0.65, $\beta$ = 0.04 Former: 0.12 (0.23), <i>p</i> = 0.60, $\beta$ = 0.05
Eriksen Flanker – congruent z-score	0.05 (0.93)	-0.28 (1.31)	0.02 (0.84) <i>n</i> = 83	Never/Minimal: 0.08 (0.24), <i>p</i> = 0.74, $\beta$ = 0.03 Former: -0.20 (0.23), <i>p</i> = 0.38, $\beta$ = -0.08
Eriksen Flanker – incongruent z-score	-0.06 (0.97)	-0.17 (0.94)	0.003 (0.90) <i>n</i> = 83	Never/Minimal: 0.002 (0.24), <i>p</i> = 0.99, $\beta$ = 0.001 Former: -0.06 (0.23), <i>p</i> = 0.79, $\beta$ = -0.03
Useful Field of View – processing z-score	0.19 (1.27) <i>n</i> = 24	-0.02 (1.21)	-0.04 (0.86) <i>n</i> = 81	Never/Minimal: -0.005 (0.26), <i>p</i> = 0.98, $\beta$ = -0.002 Former: -0.07 (0.25), <i>p</i> = 0.79, $\beta$ = -0.02
Useful Field of View – divided attention z-score	0.47 (1.21) <i>n</i> = 24	0.10 (1.21)	-0.16 (0.84) <i>n</i> = 81	Never/Minimal: 0.42 (0.24), <i>p</i> = 0.08, $\beta$ = 0.16 Former: 0.16 (0.23), <i>p</i> = 0.48, $\beta$ = 0.06
Useful Field of View – selective attention z-score	0.11 (0.88) <i>n</i> = 23	0.27 (1.24)	-0.10 (0.96) <i>n</i> = 78	Never/Minimal: 0.01 (0.24), <i>p</i> = 0.96, $\beta$ = 0.005 Former: 0.31 (0.23), <i>p</i> = 0.19, $\beta$ = 0.12

<sup>a</sup>: Controlled for age, education, sex, race and smoking pack years with “current drinkers” serving as the standardization reference.



**Table 3**

Cognitive Performance Data by Alcohol Drink Years.

	All	Former	Current
	Adjusted Coefficient <sup>a</sup> (standard error), Significance and Standardized Beta		
3MS total score	0.01 (0.01), $p = 0.21$ , $\beta = 0.10$ $n = 127$	0.03 (0.02), $p = 0.23$ , $\beta = 0.36$ $n = 22$	0.009 (0.01), $p = 0.46$ , $\beta = 0.08$ $n = 80$
Composite z score at baseline	-0.0001 (0.0008), $p = 0.88$ , $\beta = -0.01$ $n = 117$	-0.001 (0.001), $p = 0.39$ , $\beta = -0.21$ $n = 21$	-0.00004 (0.001), $p = 0.97$ , $\beta = -0.005$ $n = 73$
Verbal (letter) fluency z-score	0.003 (0.002), $p = 0.28$ , $\beta = 0.09$ $n = 127$	-0.001 (0.005), $p = 0.85$ , $\beta = -0.05$ $n = 22$	0.005 (0.003), $p = 0.08$ , $\beta = 0.20$ $n = 80$
Category fluency z-score	-0.001 (0.002), $p = 0.64$ , $\beta = -0.04$ $n = 127$	0.006 (0.006), $p = 0.37$ , $\beta = 0.28$ $n = 22$	-0.002 (0.003), $p = 0.49$ , $\beta = -0.07$ $n = 80$
RAVLT delayed recall z-score	0.0005 (0.002), $p = 0.83$ , $\beta = 0.02$ $n = 126$	-0.004 (0.005), $p = 0.49$ , $\beta = -0.19$ $n = 22$	0.001 (0.003), $p = 0.67$ , $\beta = 0.05$ $n = 79$
RAVLT total words learned z-score	0.0002 (0.002), $p = 0.92$ , $\beta = 0.008$ $n = 126$	0.0004 (0.005), $p = 0.93$ , $\beta = 0.02$ $n = 22$	-0.003 (0.003), $p = 0.32$ , $\beta = -0.10$ $n = 79$
Digit Symbol Substitution z-score	-0.001 (0.002), $p = 0.72$ , $\beta = -0.03$ $n = 126$	0.001 (0.008), $p = 0.88$ , $\beta = 0.04$ $n = 22$	0.0008 (0.003), $p = 0.80$ , $\beta = 0.03$ $n = 79$
Trails A z-score	-0.001 (0.002), $p = 0.68$ , $\beta = -0.04$ $n = 124$	-0.003 (0.005), $p = 0.63$ , $\beta = -0.13$ $n = 21$	-0.002 (0.003), $p = 0.47$ , $\beta = -0.08$ $n = 78$
Trails B z-score	-0.001 (0.002), $p = 0.66$ , $\beta = -0.04$ $n = 126$	-0.01 (0.007), $p = 0.11$ , $\beta = -0.40$ $n = 22$	0.0007 (0.003), $p = 0.79$ , $\beta = 0.03$ $n = 79$
Eriksen Flanker – congruent z-score	0.0003 (0.002), $p = 0.91$ , $\beta = 0.01$ $n = 126$	-0.005 (0.01), $p = 0.66$ , $\beta = -0.15$ $n = 22$	0.001 (0.003), $p = 0.59$ , $\beta = 0.06$ $n = 79$
Eriksen Flanker – incongruent z-score	-0.0005 (0.002), $p = 0.84$ , $\beta = -0.02$ $n = 126$	-0.01 (0.006), $p = 0.13$ , $\beta = -0.46$ $n = 22$	0.0004 (0.003), $p = 0.88$ , $\beta = 0.02$ $n = 79$
Useful Field of View – processing z-score	0.004 (0.003), $p = 0.17$ , $\beta = 0.12$ $n = 123$	-0.003 (0.008), $p = 0.72$ , $\beta = -0.10$ $n = 22$	0.004 (0.003), $p = 0.17$ , $\beta = 0.14$ $n = 77$
Useful Field of View – divided attention z-score	0.0003 (0.003), $p = 0.90$ , $\beta = 0.01$ $n = 123$	0.01 (0.007), $p = 0.16$ , $\beta = 0.38$ $n = 22$	-0.003 (0.003), $p = 0.22$ , $\beta = -0.13$ $n = 77$
Useful Field of View – selective attention z-score	0.003 (0.003), $p = 0.34$ , $\beta = 0.08$ $n = 119$	0.007 (0.008), $p = 0.42$ , $\beta = 0.22$ $n = 22$	-0.0004 (0.003), $p = 0.91$ , $\beta = -0.01$ $n = 74$

<sup>a</sup>: Controlled for age, education, sex, race and smoking pack years