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Test-Retest Reliability and Validity of Life-Course Alcohol Consumption Measures: The 2005 National Alcohol Survey Follow Up

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Abstract

Background—Few studies assess reliability and validity of lifetime alcohol measures. We undertook extended test-retest analyses of retrospective lifetime drinking measures and of incremental predictive ability of lifetime heavy drinking (days 5+ drinks) in teens, 20s and 30s for current (12-month) alcohol use disorders.

Methods—A subset (31.4%; 962 men, 1220 women) of the 2005 US National Alcohol Survey (NAS; N11) completed a follow-up survey (N11T) by phone or mail (mean delay of 2.7 years). Both surveys assessed lifetime drinking.

Results—In N11T, drinking status was reported consistently by 94.7% of N11 current drinkers, 85.5% of ex-drinkers and 74.4% of lifetime abstainers (93.5% overall). Cumulative number of prior heavy drinking days (teens through 30s) were moderately consistent (Pearson's $\rho=0.6$, $p<0.001$, $n=1,636$). Reliability was lower for younger respondents under 30 and higher for Whites versus Blacks and Hispanics ($\rho=0.68$ vs. $\rho=0.56$ vs. $\rho=0.56$, both $p=0.01$), but did not differ by gender. Heavy drinking days in teens correlated 0.63 ($p < 0.001$) for those aged 20 or older, higher for women than men and for Whites versus ethnic minorities. Heavy drinking days in the twenties and thirties reported by those 30 and older and 40 and older correlated at 0.63 and 0.67, respectively, being higher for Whites. Age of drinking onset and of lifetime maximum quantity reports were also consistent (0.65, 0.73), higher for women versus men, for those older than 29 versus younger, and for Whites versus Blacks and Hispanics. In N11, controlling for gender, age, ethnicity and current 5+ frequency, cumulative prior 5+ days (teens to age 39) predicted current alcohol-related consequences and dependence (both $p=0.003$).

Conclusions—Measurements of earlier heavy drinking is feasible, efficient, and reasonably reliable, albeit with some individual imprecision. Prior drinking data improve prediction of current alcohol use disorders, adjusting for demographics and current drinking.

Keywords

alcohol measurement; lifetime measures; survey; self-report; validity; reliability

Introduction

Many methodological problems remain to be solved in lifetime drinking measurement (Lemmens, 1998). Our extended test-retest and predictive validity study aimed to set some boundaries on the extent of one of the limitations he identified—the dearth of reliability and validity information. In this introduction we examine first the value of heavy drinking measures since these are at the root of most of the lifetime measures we study here. Next, we briefly review several lifetime alcohol measures, assessing suitability for use in surveys. We consider the importance of the lifetime perspective and summarize key reliability and validity results, which is the main thrust of the new test-retest and validity research we present for lifetime measures included in the National Alcohol Survey (Kerr and Ye, 2010).

Measuring Heavy Drinking and Maximum Consumption

Heavy drinking measures have a long history (Greenfield, 1986) but their recent ascendancy suggests a paradigmatic shift (Rehm et al., 1996).

Heavy drinking, including “binge drinking” (Wechsler et al., 1994), is here defined as five or more drinks per day (5+) for both genders. In the US with a 14 g standard drink (Turner, 1990), this would be a 70 g ethanol threshold. Although 5+ for men and 4+ for women have been recommended (Wechsler et al., 1995) but due to data limitations, gender-equivalent 5+ definitions, as used here, remain valuable, especially in longer-term survey series (Kerr et al., 2009; Serdula et al., 2004). Because standard drinks vary across countries (Turner, 1990) our results are primarily applicable to the US and even here there remains some imprecision since drink pours also vary across individuals and for wine and spirits drinks especially are often larger than a standard drink [Kerr, 2005 #14950].

Response options in measures affect reporting and categorical scales (as will be used here) tend to elicit higher frequencies of heavy drinking than open-ended formats (Ivis et al., 1997). In addition to studying lifetime heavy drinking (5+) we also investigate consistency in reporting the largest number of drinks ever consumed in a day, or lifetime maximum. Maximum is valuable for predicting alcohol use disorders (Greenfield et al., 2006) and numerous alcohol-related risks, e.g., criminal behavior (Greenfield, 1998). On a lifetime basis, maximum drinks ever consumed in any day is now recognized as an important phenotype descriptor related to alcoholism (Malone et al., 2010).

Lifetime Drinking Measures

Clinical studies have relied on a number of retrospective techniques. These include the Timeline Follow-Back method (Sobell and Sobell, 1992), the Lifetime Drinking History (LDH) (Koenig et al., 2009; Skinner and Sheu, 1982) and other paper-and-pencil lifetime drinking measures (Lemmens et al., 1997).

Short duration measures such as 7-day, 30-day or 12-month consumption summaries) cannot estimate cumulative exposure (Rehm et al., 2006), which is important, for example, as a risk factor for cancer (Nelson et al., 2013). Self-reports of earlier drinking are also vital to depict a lifetime trajectory of drinking. Nonetheless, the lifetime drinking perspective (Parrish et al., 1993), is seldom used in mortality studies (Greenfield et al., 2002) but increasingly

important. For example, former male drinkers with any heavy (5+) drinking occasions assessed by lifetime maximum have been shown to have higher risk of ischaemic heart disease mortality than those without heavy drinking (Roerecke et al., 2011). Life-course trends differ greatly across countries and possibly across cultural groups within a country (Wilsnack et al., 2009). Chen and Kandel (1995) reported the late teens and early twenties were the years of heaviest drinking in the US, substantiating the need to assess drinking during these decades. Additionally, greater instability of heavy drinking (Kerr et al., 2002) makes it important to assess heavy drinking over the life course.

Unfortunately, most lifetime measures are burdensome, impeding use in epidemiology. Understanding factors that predict persistence or change in heavy drinking is important for reducing alcohol-related harm. With longitudinal data costly to obtain and prone to attrition, a minimal set of retrospective measures, if reasonably reliable and valid, would be an asset to epidemiological surveys.

Efficient Lifetime Alcohol Assessment

Russell et al. (1997) assessed performance of two forms of a Cognitive Lifetime Drinking History measure, a “floating” time form defining life periods when drinking patterns changed and a simpler one with “fixed” decade-based age intervals. Comparison of number of times intoxicated in a lifetime assessed with both formats showed no differences and good test-retest reliability for each format.

Because heavy drinking frequency is correlated with volume (Mäkelä, 1996) decade-based 5+ frequencies can serve as a proxy for cumulative alcohol exposure (volume) when resources are constrained. Parsimony guided our decision to include an independently developed decades-based frequency of heavy drinking lifetime measure in the 1995 National Alcohol Survey (N9) and subsequent NAS surveys. Using data from the 1995 NAS, we found that the maximum rate of heavy drinking in any prior decade was related to the duration and cost of subsequent health harms (Greenfield and Rogers, 1997). Cumulative heavy-drinking days before health problem occurrence predicted reported duration of the condition ($p < 0.01$).

Recently, 2005 NAS data were used to estimate effects of life-course drinking patterns on diabetes and heart-related problems among those 40 and older (Kerr and Ye, 2010). After propensity score matching (Rubin, 1997), increased risk of diabetes was found for lifetime abstainers (OR=1.54) but not for hypertension, heart problems or high cholesterol, although significant protective and increased risks were seen in unmatched comparisons involving lifetime drinking. Current drinking involved increased risk among former heavy drinkers for all conditions. For considering morbidity outcomes like reduced heart problems and hypertension, using only current drinking levels without addressing lifetime drinking confounds findings due to the “sick quitter” bias (Shaper, 1995).

Reliability and Validity of Lifetime Drinking Measures

Reviewing retrospective assessments, Lemmens et al. (1997) found that reliability increases with age and decreases as the period of recall lengthens, although inconsistently, and that

while criterion reliability using absolute scores is poor, relative ranks provide stable estimates. The widely held assumption that retrospective measures have more downward bias than prospective ones is challenged by Koenig et al. (2009). In their 4-wave panel study (Koenig et al., 2009), reported that onset of regular drinking was “highly similar over time” (p 301). Rank order correlations at each epoch ranged from .60 to .69 for a QF Index (QFI) of intake volume. The mean and median levels of the QFI were always lower in the prospective than the retrospective assessments, suggesting past drinking levels were reported more honestly. They concluded that retrospective measures “yield meaningful and interpretable information regarding the lifetime drinking patterns” (p 302). Minimizing heavy drinking is consistent with the general underreporting of socially unacceptable behaviors (Greenfield and Kerr, 2008).

Current drinking may influence retrospective reports (Lemmens et al., 1997). In most US drinkers, this means a downward bias because drinking often decreases with age, although for some African, Asian and European subgroups, drinking can be a privilege of age. A Finnish 18-year longitudinal study found that retrospective reports yielded double the alcohol of the original reports when the country's per capita consumption had tripled in between (Simpura and Poikolainen, 1983). Thus downward bias in retrospective measures is by no means ubiquitous.

Age of drinking onset and lifetime abstinence assessments are also subject to bias (Rehm et al., 2008), including that due to “recanting”, high both for illicit drugs and alcohol use (Fendrich and Rosenbaum, 2003). In Britain only half of those reporting never having a drink at age 42 gave the same report in earlier assessments (Caldwell et al., 2006). Given reported instability in drinking status (Rehm et al., 2008), it is important to consider social factors, participant confidentiality assurances, and selective memory for alcohol use in retrospective lifetime measures. Still, recall for prior consumption has been considered reasonably unbiased for use in retrospective data imputation with missing intervening data points (Grant et al., 1997).

Historical assessments are common in surveys. Many instruments ask: “have you ever drunk alcohol ‘more than a few sips’.” Widely used is age of drinking onset, with younger age augmenting risk of lifetime alcohol dependence (Grant and Dawson, 1997; Hingson et al., 2006). Longitudinal work has found age of onset questions “are of sufficient reliability for most epidemiological applications” (Johnson and Mott, 2001). One demanding recall task is number of drinks needed to “feel the effects” the first five times the respondent drank, which together with similar items, indicates low response (LR) to alcohol, a high-risk phenotype for alcohol dependence (Schuckit et al., 2003). Clearly lifetime drinking and heavy drinking measures deserve more psychometric study (Lemmens, 1998; Lemmens et al., 1997).

Even though lifetime history measures have existed for three decades (Skinner and Sheu, 1982) and historical measures predict future risks (Greenfield and Kerr, 2008), there has been little uptake. Most epidemiological surveys limit assessment to recent (current) drinking. If reliability and validity the simpler fixed-period lifetime measures were demonstrated, they might be more widely adopted (Greenfield and Kerr, 2003). These measures would benefit studies on aging, natural versus treated recovery (Greenfield et al.,

1998; Sobell et al., 1993), and health harms from drinking (Kerr and Ye, 2010; Lown et al., 2007). Cross-sectional series, single-point and baseline panel assessments would all benefit by lifetime measures (Greenfield, 1994).

Lemmens (1998) asked how much detail can we expect respondents to provide with decent reliability? Here we examine factors associated with use of alcohol that may affect its reporting and by extension, report consistency. These factors include gender, age, ethnicity, past year heavy drinking and alcohol use disorders. In addition, as a validation step, we assess whether decades-based cumulative heavy drinking frequency measures, over and above current heavy drinking frequency, can improve the prediction of current alcohol dependence and consequences.

Materials and Methods

Procedure

The N11T follow-up questionnaire was administered at an average of 2.7 (min=2.4, max=3.7) years following the N11 baseline as part of a tracing effort that was started when funds became available. The range of follow-up times reflects the period over which initial Interviews for N11 were completed between 2005 and early 2006. Sampling included adults in all US states, using list-assisted random digit dial (RDD) (with Black, Hispanic and low-population-states oversampled). Computer-assisted telephone interviewing (CATI), achieved a cooperation rate of 56% overall (Greenfield et al., 2009; Greenfield and Rogers, 1997; Greenfield et al., 1998). Weighting accounted multiplicatively for (a) probabilities of selection, e.g., number of telephones, household members, and oversampling; (b) non response likelihood, and (c) post-stratification based on US region, gender, age and ethnic group, using the US Census *Current Population Survey (CPS)*. At the end of the N11 interview, participants were asked, in case we followed them up, to provide identifying information, to be kept separate from their responses. The N11T data were obtained from a sub-sample (31.4%) of NAS11 respondents who provided follow-up information and were contacted either by a postal booklet returned as a pre-paid mailer ($n=734$) when an address was available, or by telephone ($n=1,449$, 66.4%) for those with phone contact information only, or when unopened mail was returned by the Post Office, or those who did not respond using the ID-coded booklet after one postal reminder. A recruitment letter (mail) or telephone preamble requested voluntary participation. Prior to conducting lifetime drinking analyses, we examined whether N11T data obtained by 2 different administration modes (mail and phone) could be combined. Unweighted χ^2 analyses were used for comparing demographics across survey mode. Additionally, weighted analyses were used to check mode effects on alcohol use indicators (results not shown).

Sample

We analyze the N11 data linked to responses from the brief N11T follow-up. All comparisons of demographics between N11 group not followed and followed up in N11T are reported unweighted. Comparisons of alcohol use and alcohol use disorders (AUDs) involve weights that renormalize the N11 and N11T combined sample weights to yield similar distributions of White vs. other ethnicity, gender, and age for the both samples,

referenced to the 2005 US Census *CPS*. The lifetime heavy drinking validity analyses with the criterion of predicting alcohol problems use all available cases from the original N11 sample, weighted. Table 1 provides information on demographics and past year alcohol use for N11T respondents, and N11 respondents who did not complete N11T. Compared to non-followed respondents, N11T respondents were more likely to be female, older, and White. Using analyses with weights to make N11T data representative of the 2005 US population, no differences were found between N11T followed and not-followed N11 respondents on any alcohol use in the past year. However, N11T-followed respondents were *less* likely than those not followed to report at least monthly heavy drinking (5.0% vs 6.8%) and report 12-month AUDs (3.0% vs 4.0%).

Measures

Age of drinking onset was assessed by asking: “About how old were you when you first started drinking alcoholic beverages, not including small tastes?”. *Heavy drinking in prior decades* was assessed up to age 39 for lifetime drinkers, defined as those who ever consumed any alcohol in their whole lifetime. Three items assessed the frequency of drinking five or more (5+) drinks on one occasion during specific life decades, i.e., the teens, 20's and 30's, using 5 response options: “every day or nearly every day”, “at least once a week”, “at least once a month”, at least once a year”, and “never”. For N11T, response options were “At least three times a week”, “at least once a week”, “at least once a month”, “at least once a year” and “never”. For current analyses, N11 and N11T response options were considered the same, with the top category coded as 300 days (between nearly every day and at least 3 times per week). Analyses examined a) total number of heavy drinking days in each specific decade (teens calculation used period from drinking onset) and b) the *cumulative number of heavy drinking days* summed across the three decades. *Lifetime maximum consumption* was assessed by asking “What is the largest number of drinks you can recall EVER drinking at any ONE time?” Response options were: 24 or more drinks, 12 to 23, 8 to 11, 5 to 7, 4, 3, 2 or 1 drink.

Alcohol dependence was assessed with 17 items covering 7 domains (Caetano and Greenfield, 1997; Caetano and Tam, 1995), defined for the DSM-IV diagnosis of alcohol dependence (American Psychiatric Association, 2000). Domains assessed are: (1) Drinking larger amounts or over a longer period than intended, (2) An unsuccessful or persistent desire to cut down or control drinking, (3) A great deal of time spent in activities necessary to obtain alcohol, to drink, or to recover from its effects, (4) Important social, occupational, or recreational activities given up or reduced because of drinking, (5) Continued drinking despite knowledge of persistent or recurrent physical or psychological problems, (6) Tolerance, and (7) Withdrawal (Caetano et al., 1998). Respondents endorsing at least one item in 3 or more distinct domains were coded as dependent (American Psychiatric Association, 2000).

In N11, 15 items assess alcohol-related Consequences (Midanik and Greenfield, 2000), including five domains: work problems, fights/arguments and family reactions, accidents trouble with the law, and health problems. With the exception of the health subscale, the internal consistencies of constituent subscales in prior survey data sets were good to

acceptable (alphas 0.74 - 0.87; health subscale alphas 0.58 - 0.67). The standard 2+ criterion defined a Consequences indicator (Midanik and Greenfield, 2000). Respondents positive on the dependence (3+ symptoms) or consequences (2+) were coded as positive for a 12 month alcohol use disorder (AUD).

Analysis Strategy

Reliability analyses included an examination of group differences in reporting of lifetime alcohol use by mode of survey (mail versus phone), age, gender, ethnicity, and past year heavy drinking and alcohol use disorders. For validity analyses we used all current N11 drinkers aged 21 and over ($n=3,162$) who completed the 12-month AUD measures (alcohol dependence and consequences), and all lifetime measures on N11.

Predictive Validity of Lifetime Heavy Drinking—Two sets of logistic regression models were estimated, separately predicting 3+ DSM-IV symptoms (Table 4) or 2+ tangible consequences (Table 5) in the past 12 months. The first set included all respondents aged 21 and older to allow for the examination of cumulative prior lifetime heavy drinking days in prior decades (i.e., teens for those age 21-30, teens and 20s for those age 31-40, and teens, 20s and 30s for those aged 41+) as shown in the tables. A second set of models included only respondents age 41 and older and examined lifetime heavy drinking days in three prior decades, i.e., teens, 20s and 30s (results not shown). Restricting the age of respondents in both analyses helped distinguish past year 5+ days from cumulative lifetime 5+ days. Covariates in each set of models included age, gender, race/ethnicity, and number of past year 5+ days (model 1), adding the cumulative number of prior 5+ days in the prior decades (model 2), and adding age of onset (model 3).

Analyses with those age 21 or more included 3,162 respondents (White=2,206; Hispanic=558, Black=398). The heavy drinking variables were scaled as follows: For current (past-year) heavy drinking, the highest possible frequency that could be reported was 365 days. However, for each decade-specific question, the highest possible frequency was 260. This was due to the spacing between the highest and next to highest frequency categories (i.e., for the prior-year, the next highest category was ‘3-4 times/week’ whereas for the decade-specific items, the next highest category was ‘at least once a week’, yielding different frequency bin midpoints for the two variables). To aid in interpretation of coefficients, both the current heavy drinking variable and the cumulative lifetime variable were rescaled such that an increase in 1 in the rescaled variable corresponded to a 10% increase across the range of the variable in question (i.e., 36.5 days for 12-month current 5+ and $780 = 260 \times 30 / 10$ days for the lifetime measure) based on respective ranges. Linearity of the logit transformation in the lifetime and current frequency of heavy drinking was tested by categorizing the covariate into quartiles and examining the resulting coefficient estimates. In addition, as a measure of how well the covariates differentiate the 0/1 dichotomous outcome, area under the receiver operating characteristic (ROC) curve was estimated for each model.

Results

Preliminary Results

No differences were found by N11T mode in gender (both 55.9%), race/ethnicity (e.g., White: mail: 70.3%; phone: 67.8%). However, compared to phone, mail respondents were more likely to be aged 60 or older (mail, 37.1%; phone, 32.7%; $p < 0.05$). Current alcohol use was more likely to be reported by mail respondents (mail, 62.1%; phone, 56.2%; $p < 0.01$). However, rates of past year monthly heavy drinking (mail, 4.9%; phone, 5.0%), or any AUDs (mail, 3.8%; phone, 2.7%) did not differ by N11T mode. For further analyses data from the two tracer modalities were pooled.

In all, 2,078 respondents provided lifetime drinking information at both N11 and at N11T, with 104 (4.8%) missing on either assessment. The number of respondents consistently reporting any lifetime alcohol use who provided information on other specific lifetime alcohol use measures varied (as given in the tables).

Alcohol Use

Ever having consumed alcohol was reported consistently by 93.3% current drinkers and ex-drinkers (N11 status); 86.5% of lifetime abstainers at N11 reported being abstainers at follow-up (see Table 2). For *Age of onset of drinking* the test-retest correlation for the overall sample was 0.65 ($R^2=0.42$, $p < .001$, tested using the Fisher's z-transformation); higher for women than men, and for those aged 30 to 39 and respondents of age 60 and over. Although not significantly so, reliability was slightly lower for Blacks versus Whites or Hispanic respondents (0.57 vs 0.70 vs 0.67; *NS*). Reliability did not differ by mode of N11T, reporting of any past year AUDs, or lifetime childhood abuse on N11. However, reliability was lower for respondents reporting any 5+ days compared to no heavy drinking on N11 (0.55 vs. 0.68, $p < 0.05$)

Lifetime maximum quantity reported at N11 and N11T correlated at 0.73 ($R^2=0.53$) for the full sample, higher for women than men and lower for those aged 50 to 59 versus all other ages (Table 3). Consistency of reporting of lifetime maximum was significantly higher for Whites compared to Blacks and Hispanics. Reliability did not differ by N11T survey mode, heavy episodic drinking, or any past year AUD reported at N11.

Lifetime cumulative heavy drinking Consistency of calculated cumulative prior heavy drinking (summing teens, 20s and 30s) was examined for 1,597 respondents who reported any lifetime heavy drinking on both N11 and N11T. The cumulative number of heavy drinking days across three decades was significantly correlated ($\rho=0.61$, $R^2=0.37$, $p < 0.001$). These correlations were the lowest for those under age 30 ($\rho=0.22$), followed by that for those over 60 ($\rho=0.50$). Correlations did not differ by interview mode, gender, ethnicity, past year heavy drinking and alcohol use disorders.

Sensitivity Analyses—Examination of the 3 continuous outcome measures was performed using Bland-Altman plots (Altman and Bland, 1983), in which the difference between two continuous measures (y-axis) is plotted vs. their average (x-axis). No systematic pattern was observed for any of the measures with a small proportion of all

observations within 2 difference standard deviations from 0. Removal of all points outside of confidence limits produced identical estimates to those reported above. Due to the difference in the wording of the highest frequency category for the lifetime frequency of 5+ in N11 and N11T, an additional sensitivity analysis was carried out by instead using the quantified category midpoint corresponding to each separate measure and re-estimating the correlations in the last column of Table 3. Although plots of the two measures indicated that rates of those reporting the top category in N11 (corresponding to drinking 5+ ‘every day or nearly every day’) were slightly lower than those in N11T (defined as ‘at least 3 times a week’), each of the resulting correlation estimates were within 0.03 of those shown in Table 3 indicating no large differences between the two versions of the quantified measures.

Heavy drinking by decade Measures were also correlated between administrations for heavy drinking by decade (results not shown). The total *number of heavy drinking days* in teens correlated 0.63 for all respondents age 20 or older at N11, higher for women than men ($\rho=0.63$, $\rho=0.56$ respectively; $p=0.030$); for Whites than Blacks ($\rho=0.65$, $\rho=0.53$; $p=.018$) and Hispanics ($\rho=0.53$; $p=0.015$); higher for mail than phone follow-up ($\rho=0.61$, $\rho=0.54$; $p=0.04$) and higher for any vs. no AUD ($\rho=0.63$, $\rho=0.46$; $p=0.04$). There was no difference for past year heavy drinking vs none ($\rho=0.60$; $\rho=0.55$; *NS*).

Between administrations, the total number of 20s heavy drinking days correlated .67 for respondents age 30 and older at N11. These correlations did not differ by gender (women: $\rho=0.64$; men: $\rho=0.63$); mode of survey (mail: $\rho=0.53$; phone: $\rho=0.58$), or past year heavy drinking (none: $\rho=0.55$ vs. any: $\rho=0.56$). However consistency of heavy drinking in the 20s was higher for Whites vs. Blacks ($\rho=0.72$, $\rho=0.58$; $p=.003$) and for Hispanics vs. Whites ($\rho=0.54$; $p=.001$) and for those with any vs. no past year AUD ($\rho=0.56$, $\rho=0.53$; $p=.040$).

Similarly, the total number of heavy drinking days in the 30s correlated 0.63 for respondents age 40 and older at N11. These did not differ by gender (women: $\rho=0.60$; men: $\rho=0.59$), past year heavy drinking (none: $\rho=0.45$ vs. any $\rho=0.47$); or past year AUDs (none: $\rho=0.47$ vs. any $\rho=0.39$). Correlations were higher for Whites vs. Blacks ($\rho=0.67$, $\rho=0.55$; $p=0.032$) but *not for* Hispanics vs Whites ($\rho=0.51$; $p=0.25$) and were higher for those responding via mail than telephone ($\rho=0.62$, $\rho=0.39$, $p=0.01$).

Predictive Validity of Lifetime Heavy Drinking (Respondents aged 21 or older) As expected, current heavy drinking was a significant predictor in all models. Each 36.5-day-increase substantially increased risk for both outcomes (model 1 in Tables 4-5). Each increase of 780 days of prior lifetime heavy drinking (model 2) increased risk for alcohol dependence by 18% ($p<.05$), but was rendered non-significant when age of onset of drinking was entered into the model (model 3). Each increase of 780 days of prior lifetime heavy drinking increased risk for 2 or more consequences by 21% ($p<.001$) with past-year heavy drinking and demographics controlled for (model 2), and by 15% ($p<.05$) when age of onset of drinking was also controlled. Regarding prediction of dependence or consequences (AUD), each increase of 780 days of prior lifetime heavy drinking increased risk for any AUD by 18% but was reduced to non-significance when controlling age of onset (results not shown). Age of onset of drinking was a significant predictor of all three outcomes, with each increase of one year, the risk decreased by 12% for alcohol dependence and 8% alcohol-

related consequences (see Tables 4 and 5). The assumption of linearity of the logit in age of onset and the continuous heavy drinking predictors did not appear to be violated with coefficients for quartiles 2-4 negative for age of onset and positive for the 5+ measures, each monotonically increasing in magnitude, and roughly proportional to each other. Although coefficients for the 3rd and 4th age quartile were substantially larger than for the second, coefficients for continuous age of onset and both 5+ frequency predictors change very little in magnitude when continuous age was replaced with its categorized quartile counterpart. Hosmer-Lemeshow chi-squared goodness of fit statistics were estimated for all models, with $p > .05$ for each. Area under the ROC curve for each model was .85-.86, indicating the predictors did a good job in differentiating between each dichotomous outcome.

Discussion

Assessing drinking and heavy drinking in earlier life periods remains a challenging but valuable agenda in cross-sectional surveys and for baseline assessments in panel surveys (Greenfield and Kerr, 2008; Lemmens, 1998). Our study provides detailed information on the reliability and validity of various measures of prior drinking. The combined < 7% rate of inconsistency in ever use versus lifetime abstinence is lower than that previously reported for the 1984 follow-up (Rehm et al., 2008) perhaps due to the shorter interval between waves (Mean 2.7 years) than in the prior study's 3 waves over 8 years.

We found test-retest correlations for age of drinking onset (0.65 overall) that were higher than 0.55 reported by Koenig et al (2009) over a 5-year period but the period difference may be less important than that our measure was quite consistent, unlike theirs. The higher correlation of 0.73 for lifetime maximum suggests good consistency for this important measure. Although lifetime decades heavy drinking measures showed somewhat lower relationships, the prior lifetime cumulative 5+ days measures correlated 0.61. It must be acknowledged that some individual imprecision is inherent in retrospective reporting in the longer-term, as true even of 12-month intake (Greenfield and Kerr, 2008). For life-course retrospective self-report estimates, differences between the prospective and long-term retrospective measures may become quite large (Koenig et al., 2009; Simpura and Poikolainen, 1983). But the usual assumption that the recalled result is the biased one may not hold in light of low coverage of typical concurrent volume. While we find some reasonable stability in recall, both time points' recalls of drinking onset, maximum and decades of heavy drinking include unknown degrees of bias. Additionally, a limitation was the difference in the highest frequency categories in our two assessments, although sensitivity analyses reported earlier suggest this did not greatly influence the findings.

Because aggregated over many individuals, subgroup mean levels are likely to be more stable and minimize individual 'noise' (Bond et al., 2010). This is fortunate since in many analyses one is concerned about how subgroups differ. Further work on the degree of differences seen and their potential sources will be valuable. In general, higher levels of a variable such as maximum involve greater reporting variability (Greenfield et al., 2006) and the test-retest performance at various levels (e.g., much versus little earlier heavy drinking) needs further investigation. However, we believe that the test-retest functioning of the lifetime decades and maximum measures appears to imply enough consistency for many

epidemiological research purposes. Differences in the strength of the correlations between White, Black and Hispanic groups suggest caution is needed in drawing inferences with respect to any racial/ethnic differences observed in retrospective life-course measures. Missing data, too, is an inherent limitation, but is not excessive in our data. Although a limitation in our results is selective follow-up (based on provision of follow-up information and attrition), for such a within-person, psychometrically-oriented analysis, we do not believe this introduces drastic limitations, given our sample's diversity (Table 1). The 10-year age groupings for both the lifetime heavy drinking measures and age results presented in the tables represent limitations, particularly in the young adult period of rapid maturational changes in drinking; however, available sample sizes precluded finer-grain age groups in the analyses, and we believe participant burden and recall problems make assessment difficult for smaller time intervals than life decades.

As Koenig et al. (2009) recently concluded, we believe lifetime retrospective measures show considerable promise and reflect reasonable reliability, particularly when the absolute level is less critical than the ability to rank order survey participants. Developing and further testing brief formats suitable for survey use should be given high priority. Assessing heavy drinking frequency alone (and not volume) was a compromise based on participant burden and competition for limited survey space. Yet the simple decades-based lifetime measure has proved a useful augmentation to the NAS current drinking measures (Kerr and Ye, 2010). The use of these decades-based heavy drinking measures together with the maximum amount drunk at any time in one's life is valuable for many purposes, as reviewed earlier. Further work to explore the factors associated with high and low consistency of reporting will also be very important, and the results provided here are but a beginning.

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Table 1Demographic and alcohol-related characteristics of N11T-followed versus not-followed samples ^a

Variables	N11 Sample Not Followed ^b (N=4632) N (%)	N11 Sample Followed at N11T ^c (N=2182) N (%)
Age (p<.001)		
18-29	995 (21.5)	164 (7.6)
30-39	992 (21.4)	316 (14.7)
40-49	970 (20.9)	419 (19.5)
50-59	847 (18.3)	517 (24.0)
60 and older	828 (17.9)	735 (34.2)
Gender (p=.002)		
Male	2297 (48.1)	962 (44.1)
Female	2460 (53.2)	1220 (55.9)
Ethnicity (p<.001)		
White	2475 (52.2)	1492 (68.4)
Black	786 (16.6)	268 (12.3)
Hispanic	1243 (26.2)	367 (16.8)
Other	233 (4.9)	55 (2.5)
Drinking Status (p=.49)		
Current (past year) drinker	2850 (66.7)	1406 (68.1)
Ex-drinker	1015 (19.2)	432 (18.1)
Lifetime abstainer	872 (14.1)	344 (13.8)
Past year heavy drinking > monthly (p=.004)		
Yes	275 (6.8)	80 (5.0)
Past year any Alcohol Use Disorder (p=.042)		
Yes	190 (4.0)	50 (3.0)

^a All Ns are unweighted; percentages are weighted for the alcohol use variables only^b Data from the NAS11 for those not in the tracer sample^c Data from the NAS11 for only those in the tracer sample

Table 2Consistency between N11 and N11T of reports of lifetime alcohol use by various characteristics ^a

	N	Lifetime Drinking Percent Agreement	Lifetime Abstinence Percent Agreement	Overall Percent Agreement	Kappa ^{1,2}
ALL	1573	93.30	86.53	92.24	0.73
GENDER					$p<0.001$
Men	760	93.85	75.73	91.62	0.64
Women	778	92.62	5.07	93.09	0.80
AGE					$p<0.001$
18-29	130	93.81	64.86	89.18	0.59
30-39	248	95.88	90.32	94.90	0.83
40-49	324	93.32	96.08	93.64	0.75
50-59	368	96.02	82.14	94.49	0.74
60 and older	449	86.52	89.06	87.07	0.67
Less than 50 years	702	94.29	86.09	93.07	0.75
50 or older	817	91.23	87.91	90.68	0.70
ETHNICITY					$p=0.84$
White	1069	93.80	85.31	92.69	0.71
Black	159	92.54	80.65	90.30	0.70
Hispanic	269	88.27	90.91	88.93	0.73
TRACER INTERVIEW MODE					$p=0.72$
Phone	688	91.67	88.70	91.11	0.73
Mail	850	95.54	82.08	94.10	0.72
CHILDHOOD VICTIMIZATION					$p=0.50$
No	1092	92.67	85.43	91.37	0.73
Yes	430	94.86	93.33	94.92	0.75

a) Analyses include all respondents reporting lifetime use and an age of onset of drinking at NAS11T are included.

b) Agreement is the proportion of respondents at NAS11 reporting the same alcohol use status (lifetime use vs abstinence) at NAS11T.

c) Lifetime use and abstinence are dichotomous variables. ²all kappas in the table were significant at $p < .001$.

Table 3

Test-retest Pearson's Rho estimates for age of onset of drinking, lifetime maximum consumption, and cumulative number of Lifetime 5+ days (for teens, 20s, and 30s) among respondents reporting any lifetime alcohol consumption at both N11 and N11T.

	Age of onset of drinking		Lifetime maximum consumption		Cumulative LT # of 5+ Days ^a	
	N		N		N	
ALL	1134	0.65, R ² =.42	1397	0.73, R ² =.53	1636	0.61, R ² =.37
GENDER		<i>p</i> <0.001		<i>p</i> <0.001		<i>p</i> =0.38
Men	623	0.58	735	0.65	816	0.58
Women	511	0.73	662	0.77	820	0.59
AGE ^a		<i>p</i> <0.001		<i>p</i> =0.04		<i>p</i> <0.001
20-29	90	0.53	103	0.63	184	0.22
30-39	182	0.71	199	0.74	352	0.64
40-49	257	0.58	287	0.76	469	0.61
50-59	301	0.58	373	0.66	305	0.67
60+	290	0.73	417	0.71	325	0.50
Under 50	529	0.62	589	0.72	668	0.61
50 and older	591	0.68	790	0.69	906	0.60
ETHNICITY		<i>p</i> =0.10		<i>p</i> <0.001		<i>p</i> =0.14
White	845	0.70	1015	0.76	1198	0.64
Black	107	0.57	166	0.67	184	0.58
Hispanic	150	0.67	180	0.62	180	0.55
TRACER INTERVIEW MODE		<i>p</i> =0.38		<i>p</i> =0.22		<i>p</i> =0.06
Phone	587	0.67	519	0.73	555	0.59
Mail	547	0.66	878	0.71	1081	0.64
PAST YEAR # 5+ DAYS		<i>p</i> =0.04		<i>p</i> =0.44		<i>p</i> =0.17
None	1048	0.68	1321	0.72	1578	0.66
At least monthly	73	0.55	64	0.73	57	0.58
PAST YEAR 1+ AUD		<i>p</i> =0.08		<i>p</i> =0.23		<i>p</i> =0.39
No	1093	0.66	1362	0.72	1525	0.59
Yes	41	0.77	35	0.65	93	0.61

^a Cumulative LT prior decades 5+ Days for those aged 20-29 are # days in Teens, for ages 30-39 are # days in Teens and 20s, and for ages 40-49, 50-59, and 60+ are # days in Teens, 20s and 30s

Table 4

Predictive validity of lifetime heavy drinking for current (12 Month) 3+ DSM-IV Dependence among those aged 21+ (n=3,162)

	Model 1	Model 2	Model 3
Age	.93*** (.91, .95)	.92*** (.90, .94)	.93*** (.91, 0.95)
Gender	1.16 (.74, 1.82)	1.08 (.69, 1.70)	1.01 (0.64, 1.56)
Black Ethnicity	2.36** (1.32, 4.24)	2.35** (1.31, 4.22)	2.61*** (1.45, 4.70)
Hispanic Ethnicity	1.88* (1.10, 3.24)	1.96* (1.14, 3.37)	2.08** (1.20, 3.59)
Days 5+ past year ¹	1.60*** (1.49, 1.71)	1.56*** (1.45, 1.67)	1.58*** (1.47, 1.70)
Lifetime # 5+ Days ²	--	1.18* (1.04, 1.35)	--
Lifetime # 5+ Days ²	--	--	1.09 (0.95, 1.25)
Age of Onset	--	--	.88*** (0.82, .94)
Nagelkerke R ²	0.31	0.32	0.33
Area Under ROC	0.86	0.86	0.86

¹For interpretability, variables were scaled such that an increase in 1 corresponds to 36.5 days (a 10% increase across the original variable's range)

²For interpretability, variables were scaled such that an increase in 1 corresponds to 780 days (a 10% increase across the original variable's range)

Table 5

Predictive validity of lifetime heavy drinking for current (12 Month) 2+ Consequences among those aged 21+ (n=3,162)

	Model 1 AOR (95% CI)	Model 2 AOR (95% CI)	Model 3 AOR (95% CI)
Age	.93*** (.92, .95)	.93*** (.91, .94)	.93*** (.91, .95)
Gender	1.67* (1.09, 2.55)	1.53 [†] (.99, 2.36)	1.48 [†] (.96, 2.28)
Black Ethnicity	1.75* (1.01, 3.03)	1.74* (1.00, 3.01)	1.85* (1.07, 3.22)
Hispanic Ethnicity	.68 (.36, 1.28)	.72 (.38, 1.35)	.74 (.39, 1.39)
Days 5+ past year ¹	1.49*** (1.40, .59)	1.44*** (1.35, 1.54)	1.45*** (1.35, 1.56)
Lifetime # 5+ Days ²	--	1.21*** (1.08, 1.36)	--
Lifetime # 5+ Days ²	--	--	1.15* (1.02, 1.31)
Age of Onset	--	--	.92* (.86, .98)
Nagelkerke R ²	.26	.27	.27
Area Under ROC	.85	.85	.85

¹ For interpretability, variables were scaled such that an increase in 1 corresponds to 36.5 days (a 10% increase across the original variable's range)

² For interpretability, variables were scaled such that an increase in 1 corresponds to 780 days (a 10% increase across the original variable's range)