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AN EMPIRICAL APPROACH TO EVALUATING THE VALIDITY OF ALTERNATIVE LOW-RISK DRINKING GUIDELINES

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Abstract

Introduction and Aims—This paper proposes an approach for evaluating the validity of alternative low-risk drinking guidelines.

Design and Methods—Twenty-seven alternative guidelines were evaluated in terms of their ability to predict 9 measures of concurrent and prospective alcohol-related harm, using longitudinal data from a nationally representative sample of U.S. adults (n=26,438 to 12,339 depending upon outcome). Parameters compared included sensitivity, specificity, adjusted odds ratios and measures of model fit.

Results—Performance varied by harm. The guidelines that best predicted concurrent alcohol-related harm comprised daily-only limits of 4/3 drinks for men/women, but gender-invariant limits of 4/4 drinks also performed well. Adding weekly limits did little to improve the prediction of concurrent harm. The guidelines that best predicted prospective harm comprised daily limits of 4/4 drinks combined with weekly limits of 14 drinks for men and 7 drinks for women, with weekly limits of 14/14 drinks running second. When concurrent and incident harms were aggregated, daily-only limits of 4/3 drinks performed nearly on a par with the combination of 14/14 drinks per week and 4/3 drinks per day.

Discussion—This paper supported gender-specific daily limits and suggested that optimal guidelines might take daily limits from analyses of concurrent harms and weekly limits from analyses of prospective harms.

Conclusions—This paper illustrates a mechanism for validating the ability of low-risk drinking guidelines to accurately predict a range of alcohol-related harms, whereby countries could use their own data on consumption and its association with harm to evaluate their low-risk drinking guidelines.

Keywords

drinking guidelines; alcohol-related harm; validity; prediction

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INTRODUCTION

Attempts to prevent alcohol-related harm entail both broad measures that affect drinkers at all levels of consumption, e.g., controls on the price or availability of alcohol [1], and targeted approaches that focus on preventing drinking at levels or in patterns that increase the risk of alcohol-related harm. Drinking guidelines that define the limits of low-risk alcohol consumption are one example of the latter type of prevention effort. Defining risk drinking is a challenging undertaking, starting with the issue of how to determine the threshold that discriminates "low-risk" and "risk" drinking [2]. Perhaps the best illustration of the complexity of defining risk drinking is provided by a comparison of international low-risk drinking guidelines [3], which a number of countries have formulated with the input of expert researchers who have conducted extensive reviews of the scientific literature. The various countries' guidelines differ widely in specific limits, whether the limits apply to average consumption (usually expressed as drinks per week), maximum consumption on any given day, or both, and whether there are different limits for men and women.

There have been surprisingly few attempts to validate or compare drinking guidelines. In a cross-sectional analysis of the U.S. NIAAA drinking guidelines among past-year drinkers, Dawson [4] found that exceeding the weekly and/or daily limits yielded high sensitivity but low specificity for alcohol dependence, impaired driving, liver disease, peptic ulcer and hypertension. Specificity was improved at a higher frequency of exceeding the daily limits (≥once a week), but at some sacrifice of sensitivity. The adjusted odds of all outcomes except peptic ulcer were significantly increased among drinkers who exceeded the limits, with little additional information gleaned from considering weekly in addition to daily limits. Using a prospective framework, Batty et al. [5] examined the impact of exceeding the daily and weekly U.K. drinking limits on the occurrence of various harms over the course of a 3.6 year follow-up interval. Exceeding the daily limits increased the risk of hypertension, whereas exceeding the weekly limits increased the risk of financial problems. Exceeding the weekly (but not daily) limits was associated with a near-significant increase in the risk of accidents (p=.065). That is, the in-the-event levels of consumption typically associated with injuries appeared to increase the risk of accidents only when consumed often enough to yield a volume of intake in excess of the weekly drinking limits.

To our knowledge, there have been no studies that have systematically evaluated a wide range of drinking guidelines in terms of their associations with multiple measures of alcohol-related harm. The objective of this paper was to undertake such an analysis, focusing more strongly on the methods whereby alternative drinking guidelines could be compared than on the selection of a "best" definition of low-risk drinking. The intent was to provide a template that could be adapted for use in the evaluation of drinking guidelines in various countries, using the United States as an example.

METHODS

Sample

In order to study both cross-sectional and prospective outcomes, this study used data from two waves of the National Epidemiologic Survey on Alcohol and Related Conditions (NESARC). The 2001–2002 Wave 1 nationally representative sample contained 43,093 U.S. adults 18 and older living in households and noninstitutional group quarters, i.e., boarding and rooming houses, nontransient hotels and motels, college quarters, housing for workers, group homes and shelters (response rate = 81.0%). The 2004–2005 Wave 2 follow-up sample contained 34,653 of the original respondents, 86.7% of those eligible for reinterview, for a cumulative response rate of 70.2%. At both waves, data were weighted to reflect design characteristics of the NESARC and account for oversampling of Blacks, Hispanics

and young adults. Adjustment for nonresponse across sociodemographic characteristics was performed at the household and person levels. At both waves, weighted data were further adjusted to match the sociodemograpahic distribution of the civilian population of the United States based on the 2000 Decennial Census [6, 7]. All potential respondents were informed in writing about the nature of the survey, the statistical uses of the survey data, the voluntary aspect of their participation and the Federal laws that rigorously provide for the confidentiality of identifiable survey information. Only respondents consenting to participate after receiving this information were interviewed. The research protocol, including informed consent procedures, received full ethical review and approval from the U.S. Census Bureau and the U.S. Office of Management and Budget.

This analysis is based on two subsamples of the Wave 1 NESARC sample: 1) all past-year drinkers with no missing data on consumption (n=26,438, 98% of all past-year drinkers) and 2) a subset of past-year drinkers whose typical drink of any beverage type did not differ by more than 50% from the assumed U.S. standard drink size of 0.6 oz (≈14g) of ethanol (n=23,228, 86% of all past-year drinkers). Analyses of past-year job loss were additionally restricted to individuals who had worked at some time during the year and who reported drinking at their current level/pattern for at least a year, the latter to rule out possible increases in consumption in response to job loss (n=18,711 and 16,464 in the two subsamples). Analyses of prospective outcomes additionally excluded individuals not reinterviewed at Wave 2, and some removed individuals who had already experienced first incidence of a specific disorder by the time of the Wave 2 interview (n=12,339 to 21,886).

Measures of low-risk drinking guidelines

We arbitrarily constructed a series of 27 sets of drinking guidelines designed to vary the weekly and daily limits for men and women around the existing NIAAA guidelines for low-risk drinking: no more than 14 drinks per week or 4 drinks on any day for men and no more than 7 drinks per week or 3 drinks on any day for women [8, 9]. The 27 sets consisted of some guidelines with both weekly and daily limits (n=15) and others with weekly-only limits (n=10) or daily-only limits (n=2). Weekly limits ranged from 21 to 7 drinks per week, a range that extended both below and above the limits in the current NIAAA low-risk drinking guidelines [9] and featured both gender-specific and gender-invariant limits. Daily limits consisted of either 4 drinks for both men and women or 4 drinks for men and 3 drinks for women, reflecting the two most commonly-used measures of risk drinking, 5+ drinks and 5+/4+ drinks [10, 11].

Measures of exceeding drinking guidelines

For each set of drinking guidelines, two measures of risk drinking were created. The first was a simple dichotomous measure in which individuals were counted as exceeding the weekly limits if their *average* weekly number of drinks exceeded the weekly limits or their largest quantity of drinks consumed in a single day for all beverage types combined exceeded the daily limits. Average weekly drinks was a weighted function of their self-reported overall frequency of drinking, usual number of drinks, largest number of drinks, frequency of drinking the largest quantity and frequency of drinking 5+ drinks. Individuals were counted as exceeding guidelines with both weekly and daily limits if they exceeded *either* the weekly or daily limits.

A second categorical risk drinking measure reflected the *extent* to which the guidelines were exceeded. For guidelines with both weekly and daily limits, the categories were: exceeded the daily limits ≥weekly; exceeded the daily limits ≥ monthly but <weekly; exceeded the daily limits < monthly *or* exceeded the weekly limits only; and did not exceed either the weekly or daily limits. For guidelines with daily limits only, the categories were: exceeded

the daily limits ≥weekly; exceeded the daily limits ≥monthly but <weekly; exceeded the daily limits < monthly; and did not exceed the daily limits. For guidelines with weekly limits only, the categories were: exceeded the weekly limits by a factor of ≥2.0 (i.e., drank at least twice the weekly limit); exceeded the weekly limits by a factor of 1.5 to <2.0; exceeded the weekly limits by a factor of <1.5; and did not exceed the weekly limits.

Measures of alcohol-related harm

This analysis examined five measures of concurrent harm (Wave 1 past-year alcohol dependence, alcohol abuse, injury, job loss, and hypertension) and four measures of prospective harm (Wave 1 - Wave 2 incidence of alcohol dependence, alcohol abuse and liver disease and Wave 2 past-year heart attack (myocardial infarction) or stroke. Measurement of past-year alcohol abuse and dependence conformed to the DSM-IV criteria for these disorders [12]; the multiple symptom item questions used to operationalise each abuse and dependence criterion, as well as their derivation and psychometric properties, have been described in detail elsewhere [13–15]. Past year job loss was based on the question “In the last 12 months, were you fired or laid off from a job?” and past-year injury on the question “In the past 12 months, how many injuries have you had that caused you to seek medical help of to cut down your usual activities for more than half a day?” Past-year hypertension was based on the question “In the past 12 months, have you had high blood pressure or hypertension?” and positive responses additionally required that the respondent report the condition having been confirmed by a physician/health professional.

Wave 2 incident alcohol abuse and alcohol dependence required that respondents meet the criteria for those disorders for the first time in the interval between the Wave1 and Wave 2 interviews. Individuals with a positive lifetime history of alcohol dependence at Wave 1 were excluded from the analysis of incident dependence, and those with lifetime histories of abuse or dependence were excluded from the analysis of incident abuse, as per the DSM-IV [12]. To be positive for incident liver disease, respondents had to positively endorse having physician-confirmed “cirrhosis of the liver” or “any other form of liver disease” in the year preceding the Wave 2 interview; those who reported past-year liver disease at Wave 1 were excluded from the analysis of incident liver disease. To be positive for incident heart attack or stroke, respondents had to positively endorse having physician-confirmed “myocardial infarction or heart attack” or “stroke” in the year preceding the Wave 2 interview. Because of the episodic nature of these events, individuals with previous heart attacks or strokes were retained in the analysis.

Analysis

We first assessed the performance of the alternative low-risk drinking guidelines using unadjusted sensitivity/specificity analyses. Two-by-two tables of each outcome by each dichotomous measure of exceeding the guidelines yielded the guidelines’ sensitivity (proportion exceeding the guidelines among individuals positive for the outcome) and specificity (proportion *not* exceeding the guidelines among individuals negative for the outcome). We then estimated adjusted associations between the harm outcomes and drinking guidelines using multivariate logistic regression models that adjusted for age, sex, race-ethnicity, education, marital status and past-year smoking status; the models for hypertension, liver disease and heart attack/stroke also controlled for obesity. The intent of these models was not to fully explain the outcomes, but rather to examine differential associations across guidelines, ruling out major potential confounders. The models yielded a) odds ratios (OR) that showed how greatly the risks of the outcomes differed between individuals who did and did not exceed the drinking limits, and b) goodness of fit statistics that showed how accurately the guidelines predicted the harm in question, the former based on the dichotomous measures of exceeding the drinking guidelines and the latter based on

the 4-level categorical measures. Models were estimated using SAS Version 9.2 [16], because the complex sample design of the NESARC did not affect the performance parameters used in this analysis. We attempted to selected goodness of fit statistics that were conceptually distinct: the pseudo-R-square indicating proportion of variance explained, the inverse of the Hosmer-Lemeshow lack of fit chi-square (since higher values indicate poorer model fit), the Wald chi-square for the risk drinking model parameter and the gamma statistic, a measure of concordantly versus discordantly predicted outcomes [16,17].

To create a composite measure of performance that would represent an average across the seven performance parameters, we adjusted for differences in scale and dispersion among the parameters by means of an adjusted ratio transformation process that is described in the Supporting Information S1. This resulted in scores ranging from 1.000 to ≈3.000 for each type of harm. In addition, we created an average across the nine types of harm, i.e., an average across both type of performance parameter and type of harm. Finally, we examined how these summary scores varied for the two subpopulations (those with all drink sizes versus those with standard drink sizes) and according to whether men 65 and older were subjected to the women's drinking limits, as is recommended but not highlighted in the NIAAA guidelines [8, 9].

RESULTS

Table 1 shows the original and ratio-transformed performance parameters for the outcome of past-year alcohol dependence, among past-year drinkers with all drink sizes. Men 65 and older were evaluated relative the male guidelines. Despite our attempts to select conceptually distinct performance parameters, the highest parameter values clustered among the same three sets of guidelines for four of the seven parameters. Sensitivity and the adjusted OR, R-square and gamma statistics were all highest for guidelines with low weekly limits -- 10/10 (men/women) or lower -- and daily limits of 4 drinks for men and 3 drinks for women. In contrast, specificity was highest among guidelines with high weekly-only limits. The lack-of-fit and Wald chi square statistics were also highest among guidelines with weekly-only limits. The guidelines that maximised sensitivity and specificity were the same for all nine outcome measures (data not shown). In contrast, the best-performing guidelines in terms of odds ratios and goodness of fit parameters varied considerably according to outcome.

As shown in Table 2, the guidelines with the highest overall performance scores (averaged across the seven performance parameters) varied considerably by type of harm. The scores for past-year alcohol dependence tended to be highest for guidelines with gender-invariant weekly and daily limits, whereas those for past-year alcohol abuse tended to be highest for guidelines with gender invariant weekly limits coupled with gender-specific (4/3) daily limits. For past-year job loss and hypertension, the highest scores generally were observed for guidelines with gender-invariant weekly-only limits. For past-year injury, there was support for both 4/4 and 4/3 daily limits, alone or in combination with high weekly limits. For most prospective outcomes, guidelines with weekly-only limits were the strongest performers; however, incident alcohol abuse was best predicted by a combination of low weekly and 4/3 daily limits.

Table 3 shows the overall performance scores averaged across type of harm. The best performing guidelines showed a fair amount of consistency across the four scenarios defined by drink size (standard versus all sizes) and whether men's consumption was evaluated against the men's or women's drinking limits, with seven set of limits accounting for the top three performers in all of the scenarios. On average across the scenarios (right-most columns of Table 3), the best-performing guidelines for all outcomes combined consisted of 4/3 daily

limits, either alone or in combination with gender-invariant weekly limits (14/14 or 10/10). For all concurrent outcomes combined, the best guidelines consisted of 4/3 daily limits, alone or in combination with 21/21 weekly limits. For all prospective outcomes combined, weekly limits of14/7, 14/14 and 10/10, all combined with daily limits of 4/4 drinks, performed the best. It is important to note that the guidelines with the best aggregate scores do not correspond to the top-performing guidelines for any specific type of harm (data not shown).

DISCUSSION

This paper illustrated an approach for validating low-risk drinking guidelines that compares guidelines in terms of their ability to accurately predict a range of alcohol-related harms. The main strength of this approach lies in its flexibility. Researchers can choose the performance parameters and outcomes that they consider most appropriate for evaluating drinking guidelines in their countries. Although comparison of outcome measures contained in a single survey reduces “noise” associated with measurement variation across surveys, a single omnibus data source is not required for this approach. Rather, multiple data sources can be used, as long as they contain comparable consumption measures. Once the basic model parameters have been obtained from however many sources necessary to obtain a range of harm measures, the ratio transformation and averaging of performance parameters can be accomplished manually or by means of simple spreadsheet software.

Based on consumption and harm data from a representative sample of U.S. adults, this study found that the drinking guidelines that best predicted all types of harm combined and all concurrent (past-year) harm consisted of daily-only limits of 4 drinks for men and 3 drinks for women. Adding weekly limits did little to improve the prediction of these aggregate categories of harm. In contrast, the guidelines that best predicted prospective alcohol-related harm comprised daily limits of 4 drinks for both men and women, combined with moderate weekly limits that varied from 10 to 14 drinks for men and from 7 to 14 drinks for women. This raises the interesting question of whether the optimal drinking guidelines should be determined by aggregating disparate types of harm or by combining the daily limits that best predict concurrent harm with the weekly limits that best predict incident harm. The latter is the more conservative approach, and the resulting limits of 14/7 drinks per week and 4/3 drinks per day match the existing NIAAA low-risk drinking guidelines [9]. Importantly, the weekly-only limits that performed best in this study are lower than those implied by the absence of any weekly limits. That is, guidelines based solely on daily limits of 4/3 drinks per day for men/women imply upper weekly limits of seven times this quantity, or 28/21 drinks per week -- higher than the range of optimal weekly limits identified in this study. This argues for inclusion of weekly as well as daily limits, even though the weekly limits add little to the prediction of concurrent or aggregated concurrent and prospective harm.

There are numerous caveats and limitations to consider in interpreting the results of this study. First, the approach we describe is intended to evaluate drinking guidelines, not to formulate them. It is not designed to replace the laborious chore of reviewing the scientific evidence for different drinking limits. Second, the rank ordering of the performance of the different sets of guidelines was somewhat sensitive to which performance parameters and harm measures were selected and how the parameters were transformed to permit averaging. This leaves open the possibility that the choice of outcomes and parameters could be manipulated to justify any reasonable set of guidelines. It is worth noting, though, that we examined the impact on our findings of excluding a) the sensitivity and specificity parameters, b) the R-square and OR parameters, and c) the Hosmer-Lemeshow lack-of-fit chi-square. Although these omissions resulted in some changes to the best guidelines for specific types of harms, they had little effect on the top sets of guidelines averaged across

types of harm. That is, the robustness of the findings was improved by considering multiple types of alcohol-related harm.

The effects of excluding cases because of missing consumption and (for two of the four sets of analyses) nonstandard drink sizes are hard to predict. Individuals excluded for these reasons had higher rates of most of the harms included in the analyses, consistent with the assumption that missing consumption data are more common among heavy drinkers. However, the proportion of cases with missing consumption data was very low, and many of these differences reflect sociodemographic differentials that were controlled in the multivariate analyses. Moreover, different prevalence rates for the outcome measures do not necessarily imply different relationships between the drinking guideline and outcome measures. Notably, the best performing guidelines among individuals with standard drink sizes were almost identical to those for individuals with all drink sizes, suggesting that drink size exclusions did not affect these associations.

The harms chosen for analysis in this study constitute another possible limitation. Most countries' drinking guidelines are based on associations of drinking with all-cause mortality, a wide range of chronic medical conditions and acute alcohol-related harms primarily related to injury. In this study, our list of medical conditions was limited to hypertension, liver disease, heart attack and stroke, and we included alcohol use disorders and job loss, the latter as an indicator of social harm. When job loss was excluded from the analysis, there was no change in the top three sets of guidelines for predicting concurrent harm (data not shown). Replication of the analysis with different measures of harm, focusing on those known to be strongly associated with daily and weekly drinking patterns, would add support for the specific guidelines recommended in this paper. However, it is important to note that the primary goal of this analysis was to develop and illustrate a method for evaluating guidelines that could be adapted to different countries and different sets of harms.

This study found that the differences in performance among the top-performing guidelines were fairly small. Thus, the outcome of the analysis should not necessarily be seen as the selection of a single best set of guidelines but rather a range of reasonable guidelines from which a final selection can be made after taking into account other factors. These factors might include simplicity (e.g., gender-invariant limits or elimination of weekly or daily limits) and the need for limits that correspond to routinely collected consumption data in order to permit monitoring adherence to the guidelines. Finally, there is no reason to expect that results would hold across different cultures. The associations between alcohol consumption and alcohol problems may be modified by the cultural and economic milieu in which drinking occurs. In particular, frequency of drinking may affect the choice of guidelines, with weekly-only limits more well-suited for countries where daily drinking with meals is the norm than they were for the United States. Moreover, this analysis assumed a standard drink size that is larger than that used in most countries [18]. Thus, we would expect different results in countries with smaller standard drinks.

Future refinements to the approach outlined in this study might include using weighted rather than simple averages of performance parameters across outcomes. One possibility would be to weight by the prevalence of the outcome, so that selection of drinking limits would be more heavily influenced by the most common types of harms. However, the most common harms, e.g., social harms and injury, are often less strongly and significantly associated with alcohol consumption than other less prevalent harms, such as liver disease and alcohol use disorders. Thus, another possible weighting scheme would entail weights that reflect both the prevalence of the outcome and its alcohol-attributable fraction, which would amount to weighting by the alcohol-attributable rather than the overall prevalence of

the different harm measures. Performance parameters could be differentially weighted as well, e.g., to give more weight to sensitivity.

Other extensions of this approach might include examining guidelines within specific population subgroups. For example, rather than comparing gender-specific versus gender-invariant drinking limits in the total population, the optimal limits could be separately determined for men and women. This approach could also be used to determine whether lower drinking limits for elderly and young drinkers, as have been proposed in the most recent Australian drinking guidelines [19], are justified. In addition, the impact of comorbid medical and/or psychiatric conditions on the selection of drinking limits could be explored. We encourage additional research with the approach outlined in this paper and believe that it shows promise for evaluating drinking guidelines, clarifying their intent, and illustrating different aspects of the relationships between volume and pattern of drinking and alcohol-related harm.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

Acknowledgments

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Table 1

Selected statistical parameters reflecting performance of low-risk drinking guidelines in predicting Wave 1 past-year alcohol dependence among drinkers with all drink sizes, men 65+ evaluated relative to male drinking limits

Weekly limits (M/F)	Daily limits (M/F)	Sensitivity	Specificity	Adjusted OR	R-square	lack of fit chi-square	Wald chi-square	Gamma
Actual values of model parameters for models predicting past-year alcohol dependence								
28/21	4/4	89.6	72.0	13.7	0.12838	14.5	1455.8	0.783
21/21	4/4	90.1	71.7	14.3	0.12897	15.1	1452.0	0.785
21/21	4/3	92.7	66.9	15.2	0.12969	13.3	1412.2	0.790
21/14	4/4	90.5	71.1	14.6	0.12942	17.4	1443.1	0.787
21/14	4/3	92.9	66.5	15.5	0.12993	15.6	1406.0	0.791
14/14	4/4	91.8	70.0	16.6	0.13127	15.5	1426.3	0.793
14/14	4/3	94.2	65.5	18.5	0.13176	13.1	1368.1	0.796
14/10	4/4	92.6	68.9	17.7	0.13215	13.6	1401.7	0.795
14/10	4/3	94.6	64.8	19.4	0.13225	15.4	1352.2	0.798
14/7	4/4	93.0	67.9	18.1	0.13244	18.3	1385.1	0.797
14/7	4/3	94.8	64.0	20.1	0.13251	25.4	1340.2	0.798
10/10	4/4	93.2	67.5	18.5	0.13258	12.8	1392.6	0.796
10/10	4/3	95.1	63.4	20.8	0.13272	15.4	1335.1	0.799
10/7	4/3	95.4	62.6	21.7	0.13300	17.1	1321.7	0.801
7/7	4/3	95.7	61.2	22.1	0.13294	19.1	1316.7	0.801
--	4/4	89.0	72.2	12.9	0.12735	12.3	1462.8	0.777
--	4/3	92.0	67.3	14.1	0.12878	14.4	1428.0	0.785
28/28	--	40.2	96.7	13.1	0.10858	13.7	1310.8	0.669
28/21	--	42.8	96.2	13.0	0.11174	11.6	1418.6	0.684
21/21	--	48.3	94.6	11.8	0.11404	17.3	1464.7	0.699
21/14	--	51.6	93.4	11.2	0.11671	14.0	1564.7	0.711
14/14	--	61.7	90.2	12.1	0.12355	14.9	1653.6	0.735
14/10	--	65.6	88.4	11.8	0.12643	12.5	1735.9	0.744
14/7	--	68.7	86.7	11.9	0.12823	15.8	1758.2	0.757

Weekly limits (M/F)	Daily limits (M/F)	Sensitivity	Specificity	Adjusted OR	R-square	lack of fit chi-square	Wald chi-square	Gamma
10/10	--	70.9	84.9	11.7	0.12665	19.1	1649.0	0.753
10/7	--	73.9	83.2	11.7	0.12860	25.0	1686.8	0.764
7/7	--	78.2	79.9	12.3	0.12919	14.5	1603.4	0.767
Ratio-transformed values of model parameters for models predicting past-year alcohol dependence								
28/21	4/4	2.782	1.607	1.461	2.622	2.263	1.648	2.718
21/21	4/4	2.797	1.588	1.558	2.670	2.138	1.631	2.759
21/21	4/3	2.893	1.318	1.735	2.729	2.535	1.453	2.832
21/14	4/4	2.814	1.554	1.619	2.707	1.770	1.592	2.784
21/14	4/3	2.901	1.296	1.793	2.749	2.054	1.426	2.850
14/14	4/4	2.859	1.496	1.991	2.859	2.077	1.516	2.867
14/14	4/3	2.946	1.238	2.330	2.898	2.566	1.256	2.914
14/10	4/4	2.889	1.432	2.187	2.931	2.464	1.407	2.897
14/10	4/3	2.960	1.199	2.512	2.939	2.083	1.185	2.950
14/7	4/4	2.905	1.378	2.273	2.954	1.654	1.332	2.937
14/7	4/3	2.970	1.155	2.634	2.960	1.000	1.131	2.954
10/10	4/4	2.910	1.354	2.339	2.966	2.643	1.366	2.923
10/10	4/3	2.981	1.121	2.763	2.977	2.088	1.109	2.970
10/7	4/3	2.991	1.077	2.917	3.000	1.821	1.049	3.000
7/7	4/3	3.000	1.000	3.000	2.995	1.548	1.027	2.999
--	4/4	2.758	1.620	1.304	2.538	2.796	1.679	2.640
--	4/3	2.869	1.342	1.524	2.654	2.291	1.524	2.756
28/28	--	1.000	3.000	1.355	1.000	2.429	1.000	1.000
28/21	--	1.095	2.972	1.331	1.259	3.000	1.482	1.226
21/21	--	1.291	2.881	1.099	1.448	1.790	1.688	1.462
21/14	--	1.412	2.815	1.000	1.666	2.373	2.135	1.638
14/14	--	1.777	2.632	1.154	2.226	2.175	2.532	1.993
14/10	--	1.917	2.529	1.113	2.462	2.732	2.900	2.141
14/7	--	2.027	2.437	1.120	2.610	2.027	3.000	2.328

Weekly limits (M/F)	Daily limits (M/F)	Sensitivity	Specificity	Adjusted OR	R-square	lack of fit chi-square	Wald chi-square	Gamma
10/10	--	2.106	2.332	1.083	2.480	1.557	2.512	2.271
10/7	--	2.217	2.240	1.090	2.640	1.026	2.681	2.437
7/7	--	2.372	2.051	1.199	2.688	2.255	2.308	2.483

Note: Weekly and daily limits expressed in terms of standard drinks containing approximately 0.6 oz (≈14 g) of ethanol. Highlighted cells indicate top three scores for each parameter.

Table 2

Average performance scores (mean values of ratio-transformed model parameters averaged across parameters) for selected sets of weekly and daily drinking limits and selected concurrent and prospective outcomes, based on logistic regression models adjusted for Wave 1 age, sex, race-ethnicity, education, marital status and smoking[a] Drinkers with all drink sizes, men 65+ evaluated relative to male drinking limits

Weekly limits (M/F)	Daily limits (M/F)	Wave 1 past-year (Concurrent):					Wave 2 (Prospective)[b]:			
		Alcohol dependence	Alcohol abuse	Job loss	Injury	Hyper-tension	Alcohol dependence	Alcohol abuse	Liver disease	Heart attack or stroke
28/21	4/4	2.157	2.543	2.024	2.544	1.721	1.970	1.959	1.863	2.163
21/21	4/4	2.163	2.536	2.001	2.492	1.793	2.012	1.959	1.836	2.133
21/21	4/3	2.214	2.602	2.212	2.407	1.828	1.841	2.061	1.941	1.907
21/14	4/4	2.120	2.552	1.923	2.456	1.879	2.007	1.966	2.216	2.086
21/14	4/3	2.152	2.632	2.214	2.359	1.868	1.839	2.061	1.957	1.907
14/14	4/4	2.238	2.593	1.819	2.187	1.859	1.992	2.125	2.171	2.058
14/14	4/3	2.307	2.686	2.027	2.125	1.764	1.858	2.325	1.973	1.941
14/10	4/4	2.315	2.573	1.800	2.111	1.817	2.004	2.248	2.029	2.033
14/10	4/3	2.261	2.606	2.010	2.176	1.812	1.866	2.355	1.893	1.901
14/7	4/4	2.205	2.561	1.638	1.946	1.729	2.004	2.353	1.997	2.058
14/7	4/3	2.115	2.559	2.040	2.049	1.660	1.865	2.418	1.889	1.973
10/10	4/4	2.357	2.570	2.026	2.058	1.828	1.955	2.327	1.862	2.116
10/10	4/3	2.287	2.618	2.268	2.155	1.853	1.871	2.405	1.903	1.982
10/7	4/3	2.265	2.563	2.298	1.992	1.701	1.861	2.511	1.902	2.001
7/7	4/3	2.224	2.684	2.122	1.805	1.684	1.889	2.556	1.818	2.002
--	4/4	2.191	2.510	1.886	2.674	1.722	1.936	1.932	1.884	2.179
--	4/3	2.137	2.586	2.214	2.512	1.809	1.832	2.025	2.007	1.895
28/28	--	1.541	1.356	1.845	1.855	2.087	1.659	1.578	1.517	2.382
28/21	--	1.766	1.342	1.840	1.491	2.073	1.823	1.593	2.176	2.475
21/21	--	1.666	1.422	2.434	1.727	1.937	2.033	1.787	2.078	1.899
21/14	--	1.863	1.441	2.155	1.552	2.035	2.186	1.736	2.347	2.080
14/14	--	2.070	1.594	2.168	1.477	2.330	2.246	1.886	2.266	1.521
14/10	--	2.256	1.666	1.858	1.403	2.167	2.215	2.064	2.197	1.664

Weekly limits (M/F)	Daily limits (M/F)	Wave 1 past-year (Concurrent):					Wave 2 (Prospective)[b]:			
		Alcohol dependence	Alcohol abuse	Job loss	Injury	Hyper-tension	Alcohol dependence	Alcohol abuse	Liver disease	Heart attack or stroke
14/7	--	2.221	1.744	2.098	1.443	1.626	2.131	2.144	2.234	1.722
10/10	--	2.049	1.787	2.369	1.421	2.178	2.303	1.943	2.150	1.750
10/7	--	2.047	1.851	2.177	1.496	2.116	2.315	2.033	2.068	1.742
7/7	--	2.194	1.947	1.558	1.371	2.308	2.137	1.989	1.793	1.659

Note: Weekly and daily limits in standard drinks of approximately 0.6 oz (≈14 g) of ethanol. Shaded cells denote top three scores for each outcome.

[a] Models for hypertension, liver disease, and heart attack/stroke additionally adjusted for obesity.

[b] Alcohol abuse and dependence reflect incidence since Wave 1 interview, whereas liver disease, heart attack and stroke reflect Wave 2 past-year conditions/events.

Table 3

Mean values of ratio-transformed model parameters (averaged across parameters and outcomes) for selected sets of weekly and daily drinking limits, as a function of drink size (standard versus all) and whether men 65+ are evaluated with respect to men's or women's limits

		Drinkers with standard drink sizes		Drinkers with all drink sizes		Average across (1) to (4)		
Weekly limits (M/F)	Daily limits (M/F)	Men 65+ evaluated relative to:		Men 65+ evaluated relative to:				
		Men's limits (1)	Women's limits (2)	Men's limits (3)	Women's limits (4)	All outcomes	Concurrent outcomes	Prospective outcomes
28/21	4/4	2.125	2.128	2.095	2.086	2.109	2.191	2.005
21/21	4/4	2.105	2.121	2.096	2.102	2.106	2.184	2.009
21/21	4/3	2.130	2.137	2.110	2.137	2.129	2.234	1.996
21/14	4/4	2.129	2.120	2.128	2.115	2.123	2.157	2.081
21/14	4/3	2.119	2.115	2.107	2.104	2.111	2.195	2.007
14/14	4/4	2.131	2.148	2.118	2.127	2.131	2.141	2.118
14/14	4/3	2.143	2.149	2.113	2.138	2.136	2.165	2.099
14/10	4/4	2.097	2.095	2.107	2.104	2.101	2.091	2.113
14/10	4/3	2.117	2.112	2.108	2.100	2.109	2.139	2.071
14/7	4/4	2.099	2.084	2.060	2.021	2.066	2.023	2.119
14/7	4/3	2.100	2.089	2.065	2.084	2.084	2.072	2.101
10/10	4/4	2.089	2.107	2.125	2.120	2.110	2.106	2.115
10/10	4/3	2.128	2.114	2.152	2.134	2.132	2.180	2.073
10/7	4/3	2.110	2.088	2.129	2.116	2.111	2.124	2.094
7/7	4/3	2.075	2.080	2.082	2.100	2.084	2.088	2.080
--	4/4	2.124	2.129	2.095	2.099	2.112	2.207	1.993
--	4/3	2.137	2.131	2.117	2.141	2.132	2.239	1.998
28/28	--	1.718	1.748	1.811	1.724	1.750	1.731	1.773
28/21	--	1.826	1.815	1.894	1.779	1.828	1.654	2.047
21/21	--	1.857	1.880	1.887	1.899	1.881	1.847	1.923
21/14	--	1.932	1.915	1.935	1.927	1.927	1.804	2.081
14/14	--	1.936	1.958	1.951	1.966	1.953	1.930	1.981
14/10	--	1.998	1.979	1.951	1.964	1.973	1.896	2.070

		Drinkers with standard drink sizes		Drinkers with all drink sizes		Average across (1) to (4)		
Weekly limits (M/F)	Daily limits (M/F)	Men 65+ evaluated relative to:		Men 65+ evaluated relative to:		All outcomes	Concurrent outcomes	Prospective outcomes
		Men's limits (1)	Women's limits (2)	Men's limits (3)	Women's limits (4)			
14/7	--	1.986	1.947	1.924	1.891	1.937	1.859	2.035
10/10	--	1.996	2.029	1.998	2.017	2.010	1.969	2.062
10/7	--	1.987	2.001	1.989	1.970	1.987	1.934	2.052
7/7	--	1.967	1.988	1.888	1.893	1.934	1.909	1.965

Note: Weekly and daily limits in standard drinks of approximately 0.6 oz (≈14 g) of ethanol. Shaded cells denote top three scores for each outcome.