

# Two Brief Alcohol-Screening Tests From the Alcohol Use Disorders Identification Test (AUDIT)

## Validation in a Female Veterans Affairs Patient Population

Katharine A. Bradley, MD, MPH; Kristen R. Bush, MPH; Ameer J. Epler, BA; Dorcas J. Dobie, MD; Tania M. Davis, PhD; Jennifer L. Sporleder, BS; Charles Maynard, PhD; Marcia L. Burman, MD, MPH†; Daniel R. Kivlahan, PhD

**Background:** Primary care physicians need a brief alcohol questionnaire that identifies hazardous drinking and alcohol use disorders. The Alcohol Use Disorders Identification Test (AUDIT) questions 1 through 3 (AUDIT-C), and AUDIT question 3 alone are effective alcohol-screening tests in male Veterans Affairs (VA) patients, but have not been validated in women.

**Methods:** Female VA patients (n=393) completed self-administered questionnaires, including the 10-item AUDIT and a previously proposed modification to AUDIT question 3 with a sex-specific threshold for binge drinking ( $\geq 4$  drinks/occasion), and in-person interviews with the Alcohol Use Disorder and Associated Disabilities Interview Schedule. The AUDIT-C, AUDIT question 3 alone, and the 10-item AUDIT were each evaluated with and without the sex-specific binge question and compared with past-year hazardous drinking ( $> 7$  drinks/week or  $\geq 4$  drinks/occasion) and/or active *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition* alcohol abuse or dependence, based on interviews.

**Results:** Eighty-nine women (22.6%) met interview criteria for past-year hazardous drinking and/or active alcohol abuse or dependence. Standard and sex-specific AUDIT-Cs were sensitive (0.81 and 0.84, respectively) and specific (0.86 and 0.85, respectively). Their areas under the receiver operating characteristic curves were equivalent (0.91, and 0.92, respectively) and slightly higher than for the standard 10-item AUDIT (0.87). A single, sex-specific question about binge drinking (modified AUDIT question 3) had a sensitivity of 0.69 and specificity of 0.94, whereas the standard AUDIT question 3 was specific (0.96) but relatively insensitive (0.45).

**Conclusions:** The standard and sex-specific AUDIT-Cs are effective screening tests for past-year hazardous drinking and/or active alcohol abuse or dependence in female patients in a VA study.

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**W**OMEN HAVE lower rates of alcohol abuse or dependence than men, but they are at increased risk for alcohol-related health problems at any level of alcohol consumption.<sup>1-5</sup> Randomized controlled trials have demonstrated the benefits of brief primary care interventions with women who drink more than the recommended levels (hazardous drinking) or who have experienced adverse consequences due to drinking (problem drinking).<sup>6-8</sup> However, health care providers are less likely to identify and counsel women than men with hazardous or problem drinking.<sup>9-11</sup> Women are also underrepresented in alcohol treatment.<sup>12</sup>

The underrecognition of hazardous and problem drinking in women may in part reflect the lower sensitivity of alcohol screening tests in women, especially white women.<sup>13</sup> The CAGE question-

naire (a questionnaire for identifying alcohol abuse or dependence: C Have you ever felt the need to Cut down on your drinking? A Have you ever felt Annoyed by criticism of your drinking? G Have you ever felt Guilty about your drinking? E Have you ever taken a drink (Eye-opener) first thing in the morning?) is often considered an effective screening test for current alcohol use disorders, but it has a lower sensitivity in Hispanic and white women (0.21 and 0.46, respectively) than men (0.44 and 0.69, respectively).<sup>14</sup> The CAGE questionnaire also does not identify hazardous drinking.<sup>15</sup> Longer augmented CAGE questionnaires or the Alcohol Use Disorders Identification Test (AUDIT) perform adequately in women<sup>14,16,17</sup> and identify hazardous and problem drinking, but these 7- to 10-item questionnaires are too long to be easily integrated into most primary care settings. Brief alcohol-screening tests that

Author affiliations are listed at the end of this article.

†Dr Burman died October 11, 2001.

identify women with hazardous and problem drinking are therefore needed.

The first 3 questions of the AUDIT, which ask about alcohol consumption and are called the AUDIT-C, have shown promise as a brief screening test for past-year hazardous drinking and/or active alcohol abuse or dependence.<sup>18-21</sup> The AUDIT-C was as sensitive and specific as the full 10-item AUDIT for detection of hazardous drinking or active *Diagnostic and Statistical Manual of Mental Disorders, Revised Third Edition (DSM-III-R)*<sup>22</sup> alcohol abuse or dependence in male outpatients seen in Veterans Affairs (VA) general medicine practices,<sup>18</sup> but only 2 studies of the AUDIT-C have included women.<sup>20,23</sup> A US study compared the AUDIT-C with a comparison standard for hazardous drinking, but did not present sex-specific analyses. A Belgian study validated the AUDIT-C as a screening test for *DSM-III-R* alcohol abuse or dependence. However, both of these studies used unvalidated, self-administered questionnaires for their gold standards.

The AUDIT-C question about binge drinking (AUDIT question 3) was also an effective single-item screening test in men.<sup>18,24</sup> Although AUDIT question 3 has not been evaluated in women, an emergency department study found another sex-specific question about binge drinking to be an effective screening test in women.<sup>25</sup>

The Veteran Women's Alcohol Problems Study evaluated self-administered alcohol-screening questionnaires in 393 female VA patients. One purpose of the study was to compare the AUDIT-C and AUDIT question 3 with interview criteria for past-year hazardous drinking and/or active *Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV)*<sup>26</sup> alcohol abuse or dependence. Another purpose was to evaluate a previously recommended modification to AUDIT question 3 using a sex-specific threshold for binge drinking in women ( $\geq 4$  drinks/occasion).<sup>18</sup> In this article, we present results on the performance of the following 6 screening tests: the AUDIT-C, AUDIT question 3, and the full 10-item AUDIT, each in its standard form and in a version substituting the sex-specific version of AUDIT question 3.

## METHODS

### STUDY SUBJECTS

Women who received care at the VA Puget Sound Health Care System, Seattle and Tacoma, Wash, at any time from October 1, 1996, through January 1, 1999, and had a current mailing address in 1999 were eligible for this in-person interview study. Women were excluded if they had asked not to be contacted for women's health research at our facility or had been ineligible for a mailed survey in 1998 owing to disability. All other female patients were mailed invitations and offered \$35 to participate in an interview study (N = 2548). Women who did not call, e-mail, or write indicating that they did not want to be contacted by telephone regarding the study (n = 189) were eligible (n = 2359). Of the 2359 eligible women, no contact was made with 726 (no current telephone number or no answer), and 1051 were contacted by telephone and invited to schedule an appointment. We terminated recruitment when trained interviewers were no longer available and we had recruited 396 women, approaching our goal of 400. Five hundred eighty-two women were therefore never called for recruitment. Three of the 396 recruited women did not

complete the interviews and screening questionnaires, resulting in a study population of 393.

### STUDY PROCEDURES

Women who agreed to participate on the telephone were mailed a health questionnaire and a copy of the informed consent form about 1 to 2 weeks before their scheduled interview. Alcohol-screening questions were on pages 3 to 5 of the 16-page self-administered questionnaire, which was completed before interviews. The self-administered questionnaire also included questions about health status,<sup>27</sup> mental health,<sup>28</sup> eating habits, breast pain, and physical activity.

On arrival to participate in the interview, participants were administered informed consent by trained research assistants before the completed health questionnaire was collected. Trained, nonclinician research assistants (including K.R.B., A.J.E., and J.L.S.) conducted in-person interviews from January 1 through September 30, 2000, at the VA Puget Sound Health Care System (Seattle and Tacoma, Wash) using the Alcohol Use Disorder and Associated Disabilities Interview Schedule (AUDADIS). The National Institute on Alcohol Abuse and Alcoholism developed the AUDADIS, an in-depth interview about alcohol consumption and alcohol-related experiences for the National Longitudinal Alcohol Epidemiological Survey.<sup>29</sup> The AUDADIS was designed to be administered by lay interviewers, has demonstrated reliability and validity,<sup>29-31</sup> and has been used in previous validation studies of primary care alcohol-screening tests.<sup>14,32,33</sup> Interviewers were blinded to the results of screening questionnaires.

Participants were informed that the interview was designed to test the accuracy of questions on the self-administered questionnaire, and the consent form indicated that the study was seeking to identify optimal screening questions and instruments for several conditions and health behaviors. Per the AUDADIS protocol, women were considered past-year drinkers if they indicated at the start of the AUDADIS that they had had at least 12 drinks of any kind of alcohol in the past year. Drinkers were then asked detailed questions about alcohol consumption and experiences associated with drinking alcohol. The AUDADIS modules on mood disorders, medical conditions, and other drug abuse and dependence were also administered, followed by the Clinician-Administered Post-traumatic Stress Disorder Schedule,<sup>34</sup> a diagnostic interview for post-traumatic stress disorder, although no data from these other modules are reported herein. The Human Subjects Committee of the University of Washington, Seattle, approved this study.

### ALCOHOL-SCREENING QUESTIONNAIRES

The 10 standard AUDIT questions<sup>35</sup> were preceded by the following introduction: "Consider a 'drink' to be a 12-oz can or bottle of beer, a 4-oz glass of wine, a wine cooler, 1 cocktail, or a shot (1.25 oz) of hard liquor (like gin or vodka)." Based on a previous study,<sup>15,18</sup> 2 of the first 3 questions of the AUDIT (AUDIT-C) had slightly modified response options to improve clarity and precision and to reduce missing data. The AUDIT question 1 asked, "How often have you had a drink containing alcohol in the last year?" with the following response options: never (0 points), monthly or less (1 point), 2 to 4 times a month (2 points), 2 to 3 times a week (3 points), 4 to 5 days a week (4 points), and 6 or more days a week (4 points). The AUDIT question 2 asked, "How many drinks containing alcohol did you have on a typical day when you were drinking in the last year?" with the following response options: 1 do not drink (0 points), 1 to 2 drinks (0 points), 3 to 4 drinks (1 point), 5 to 6 drinks (2 points), 7 to 9 drinks (3 points), and 10 or more drinks (4 points). The AUDIT question 3 asked, "How

often in the last year have you had 6 or more drinks on one occasion?" with the following response options: never (0 points), less than monthly (1 point), monthly (2 points), weekly (3 points), or daily or almost daily (4 points).

The AUDIT-C scores were calculated in the standard manner by summing the scores for AUDIT questions 1 to 3 (0-4 points each) with possible AUDIT-C scores ranging from 0 to 12 points.<sup>18</sup> The AUDIT question 3 was evaluated as a single-item screening test (0-4 points). The full 10-item AUDIT was also scored in the standard manner, with possible scores ranging from 0 to 40 points.<sup>35</sup>

The AUDIT question 3 asks about the frequency of drinking 6 or more drinks on an occasion, often referred to as binge drinking, and was the most sensitive AUDIT-C question for past-year hazardous drinking and/or active alcohol abuse or dependence in male VA patients.<sup>18</sup> As a single-item screening test, AUDIT question 3 alone was a more sensitive screening test for past-year hazardous drinking and/or active alcohol abuse or dependence than the CAGE at a screening threshold of  $\geq 2$  points in male VA patients (sensitivities, 0.77 vs 0.54, respectively), despite comparable specificity (0.83).<sup>24</sup> However, studies of episodic heavy drinking have shown that women who report drinking 4 or more drinks on an occasion develop adverse consequences of drinking comparable to men who report drinking 5 or more drinks per occasion.<sup>2-4,25,36</sup> Therefore, in women, AUDIT question 3 might be more sensitive if it asked about the frequency of drinking at least 4 instead of 6 drinks per occasion.<sup>18</sup> To test that hypothesis, we included a sex-specific version of AUDIT question 3 that asked about the frequency of drinking 4 or more drinks on an occasion, immediately following the standard 10-item AUDIT. Sex-specific AUDIT-C and full AUDIT scores were calculated by substituting the score for the sex-specific version of AUDIT question 3 for the standard AUDIT question 3. We also evaluated the sex-specific version of AUDIT question 3 as a single-item screening test.

## INTERVIEW CRITERION STANDARDS

### Hazardous Drinking

Alcohol consumption was estimated from the AUDADIS using the same assumptions about the size and alcohol content of drinks as a previous study using the AUDADIS.<sup>37</sup> Hazardous drinking was defined as drinking more than 7 drinks per week and/or 4 or more drinks on any occasion in the past year, based on National Institute on Alcohol Abuse and Alcoholism definitions for women.<sup>38</sup>

### Active Alcohol Abuse and Dependence

We defined alcohol use disorders (abuse or dependence) based on the AUDADIS according to criteria of the *DSM-IV*. We considered women to have active alcohol use disorders if they met *DSM-IV* criteria for past-year alcohol abuse or *DSM-IV* criteria for lifetime alcohol dependence with at least 1 adverse consequence due to drinking in the past year. This definition is comparable to comparison standards used in studies of the AUDIT-C in male VA patients<sup>15,18</sup> and another primary care alcohol-screening questionnaire validation study.<sup>39</sup>

### Main Comparison Standard

The main comparison standard used in this study was a composite of past-year hazardous drinking and/or active *DSM-IV* alcohol abuse or dependence based on the AUDADIS interviews. We chose this inclusive comparison standard because

it included all women who might benefit from any of a spectrum of primary care interventions regarding their drinking, including brief interventions,<sup>7,40-42</sup> referral to Alcoholics Anonymous or specialized alcohol treatment programs, or frequent primary care appointments for management of alcohol dependence among patients who were not ready for abstinence-oriented treatments.<sup>43</sup> Although some studies of alcohol-screening questionnaires have focused on case finding, ie, identifying patients with existing alcohol use disorders,<sup>14</sup> brief primary care interventions have been proved efficacious with patients with hazardous and milder problem drinking.<sup>7,42,44,45</sup> Therefore, expert panels have recommended primary care screening for hazardous drinking as well as alcohol abuse and dependence.<sup>38,46,47</sup>

## DEMOGRAPHIC DATA

Demographic data were obtained from the Veterans Health Information Systems and Technology Architecture for interviewed women (n=393) and all other eligible women (n=2155). In addition, age at the time of the interview (<50 or  $\geq 50$  years) was available for all interviewed women.

## ANALYSES

Descriptive statistics were calculated for demographic characteristics. To evaluate recruitment bias, we compared demographic characteristics for the 393 interviewed women and all other eligible women using the Veterans Health Information Systems and Technology Architecture data. For these analyses, we used the unpaired, 2-tailed *t* test to compare age and the  $\chi^2$  statistic to compare proportions.

Main analyses compared self-administered alcohol-screening tests with an interview comparison standard of past-year hazardous drinking and/or active *DSM-IV* alcohol abuse or dependence. We evaluated the following 6 screening tests: the AUDIT-C, AUDIT question 3, and the full 10-item AUDIT, each in its standard form and in a form substituting the sex-specific version of AUDIT question 3. We calculated sensitivity, specificity, and positive and negative likelihood ratios (with 95% confidence intervals [CIs]).<sup>48</sup> Sensitivity is the true positive rate and specificity is the true negative rate.<sup>49</sup> Positive and negative likelihood ratios (sensitivity/[1-specificity] and [1-sensitivity]/specificity, respectively) allow simultaneous evaluation of the sensitivity and specificity at each screening threshold. For a positive screening result, multiplying the positive likelihood ratio by the pretest odds of a disease gives the posttest odds of disease; for a negative screening result, multiplying the negative likelihood ratio by the pretest odds of disease gives the posttest odds of disease.<sup>50</sup> Receiver operating characteristic (ROC) curves plot the sensitivity vs 1-specificity, and we used the areas under the ROC curve to compare the overall performance of screening questionnaires. We present 95% CIs for areas under ROC curves and *P* values for important comparisons between screening questionnaires. The latter more accurately reflect differences in the performance of screening questionnaires by taking into account the correlation of areas under ROC curves from the same population.<sup>51</sup>

Secondary analyses compared each screening questionnaire with an interview-based diagnosis of active *DSM-IV* alcohol abuse or dependence alone. This comparison standard permitted us to compare findings from the present study with previous published studies of the 10-item AUDIT in women. In addition, some experts may still consider identification of alcohol abuse or dependence the central priority of primary care alcohol screening.<sup>14,20</sup>

The optimal cut point of a screening test in any particular setting depends on the prevalence of the target condition and

**Table 1. Demographic Characteristics of Interview Participants**

Characteristic	Eligible Interview Participants, No. (%) (n = 393)
Age, y	
<30	44 (11.2)
30-39	87 (22.1)
40-49	151 (38.4)
50-59	45 (11.5)
60-69	29 (7.4)
≥70	37 (9.4)
Race	
Black	48 (12.2)
White	272 (69.2)
Other/unknown	73 (18.6)
Marital status	
Never married	76 (19.3)
Married/domestic partner	145 (36.9)
Divorced/separated	128 (32.6)
Widowed	23 (5.9)
Unknown	21 (5.3)
Period of military service	
World War II or Korean War	68 (17.3)
Vietnam era	164 (41.7)
Persian Gulf War	146 (37.2)
Other or unknown	15 (3.8)

the relative costs and benefits of the screening program. The Metz equation,

$$(C/B) \times [1 - p(D)]/p(D),$$

calculates the tangent slope to the ROC curve at the optimal cut point,<sup>52</sup> where  $p(D)$  is the true prevalence of the target condition in the screened population,  $C$  is the net cost of treating individuals with false-positive screening results, and  $B$  is the net benefit of screening to individuals with true-positive screening results.<sup>52</sup> The costs ( $C$ ) for primary care alcohol screening include the time required for documenting screening results, further assessment, and follow-up of patients with false-positive screening results. If patients with false-positive screening results were inappropriately labeled or stigmatized (eg, alcoholic or in denial), the costs of alcohol screening could be increased. Benefits of alcohol screening ( $B$ ) include provider recognition of patients who might benefit from brief primary care interventions or referral for specialty treatment of alcohol use disorders. A previous study assumed that the cost-benefit ratio ( $C/B$ ) for screening with the 10-item AUDIT was equal to 1.0.<sup>14</sup> For brief screening questionnaires asking only about alcohol consumption, which take less time and are less likely to result in inappropriate labeling or stigmatization, a lower  $C/B$  ratio (0.5) may be appropriate. In this study, we therefore used the Metz equation to determine the optimal cut point for each screening method at 2 estimated  $C/B$  ratios (1.0 and 0.5), each at several prevalence rates (10%, 15%, 20%, and 25%). We first graphed the tangents to ROC curves at all cut points and then identified those cut points with slopes nearest the optimal cut points based on the Metz equation.

Analyses were conducted using SPSS software,<sup>53</sup> except statistical comparison of areas under ROC curves corrected for the correlation between areas under curves obtained from the same population,<sup>51</sup> and 95% CIs for likelihood ratios,<sup>48</sup> for which we used Excel software.<sup>54</sup>

## RESULTS

Demographic characteristics of the study population are presented in **Table 1**. The 393 women who completed

the in-person interview and self-administered screening questionnaires (15.4% of 2548 eligible women and 37.4% of 1051 women who were contacted) were predominantly white, middle-aged, and married. Compared with other women eligible for this interview study ( $n=2155$ ), the 393 interviewed participants were slightly older (mean age, 45.8 vs 43.5 years;  $P=.004$ ) and more likely to be white (69.2% vs 58.4%;  $P<.001$ ).

### PAST-YEAR HAZARDOUS DRINKING AND/OR ACTIVE DSM-IV ALCOHOL ABUSE OR DEPENDENCE

On the basis of the AUDADIS, 89 women (22.6%; 95% CI, 18.5%-26.7%) met interview criteria for past-year hazardous drinking and/or active *DSM-IV* alcohol abuse or dependence, the main interview comparison standard. Eighty-six women (21.9%; 95% CI, 17.8%-26.0%) met criteria for past-year hazardous drinking, and 39 (9.9%; 95% CI, 7.0%-12.9%) met criteria for active *DSM-IV* alcohol abuse or dependence. Among women younger than 50 years at the time of interviews, the prevalence of past-year hazardous drinking and/or active *DSM-IV* alcohol abuse or dependence was 29.4% (95% CI, 23.7%-35.1%), whereas among women 50 years or older, the prevalence was 11.0% (95% CI, 5.9%-16.1%).

### AUDIT-C

Using a screening threshold of 2 or more on either AUDIT-C resulted in sensitivities and specificities of greater than 0.80 for identification of past-year hazardous drinking and/or active *DSM-IV* alcohol abuse or dependence, with positive and negative likelihood ratios of 5.7 to 5.9 and 0.18 to 0.22, respectively (**Table 2**). As expected, the sex-specific AUDIT-C was slightly more sensitive and less specific than the standard AUDIT-C at each cut point (Table 2). The areas under the ROC curves for the standard and sex-specific AUDIT-C did not differ significantly for identification of past-year hazardous drinking and/or active *DSM-IV* alcohol abuse or dependence ( $P=.24$ ). The standard and sex-specific AUDIT-Cs were very effective screening tests for active *DSM-IV* alcohol abuse or dependence (**Table 3**), with no significant difference between the areas under their ROC curves ( $P=.93$ ).

### AUDIT QUESTION 3 ALONE

For identification of past-year hazardous drinking and/or active alcohol abuse or dependence based on interviews, the standard AUDIT question 3 had a sensitivity of only 0.45 at a cut point of at least 1, whereas the sensitivity of the sex-specific AUDIT question 3 was 0.69 (Table 2). Both versions of AUDIT question 3 had high specificities (Table 2). The sex-specific AUDIT question 3 had a higher area under the ROC curve than the standard AUDIT question 3 for identification of past-year hazardous drinking and/or active *DSM-IV* alcohol abuse or dependence (0.81 vs 0.71;  $P=.003$ ). The sex-specific AUDIT question 3 was more sensitive for active alcohol abuse or dependence (0.82) than it was for hazardous drinking and/or active alcohol abuse or dependence, although the specificity (0.86) remained high (Tables 2 and 3).



**Table 2. Performance of Screening Questionnaires for Detecting Past-Year Hazardous Drinking and/or Active DSM-IV Alcohol Abuse or Dependence (n = 89)**

Questionnaire, Cut Point	Sensitivity	Specificity	Positive LR (95% CI)	Negative LR (95% CI)	ROC (95% CI)
<b>AUDIT-C</b>					
Standard					0.91 (0.88-0.94)
≥2	0.81	0.86	5.9 (4.3-7.9)	0.22 (0.16-0.35)	
≥3	0.60	0.96	13.9 (8.0-24.4)	0.42 (0.28-0.58)	
≥4	0.38	0.98	23.2 (9.4-57.6)	0.63 (0.37-0.82)	
Sex-specific					0.92 (0.89-0.95)
≥2	0.84	0.85	5.7 (4.3-7.6)	0.18 (0.13-0.30)	
≥3	0.66	0.94	11.2 (7.0-18.0)	0.36 (0.24-0.51)	
≥4	0.48	0.99	36.7 (13.6-99.5)	0.52 (0.26-0.70)	
<b>AUDIT Question 3 Alone</b>					
Standard					0.71 (0.64-0.78)
≥1*	0.45	0.96	11.4 (6.3-20.8)	0.57 (0.39-0.75)	
≥2†	0.06	1.00	17.1 (2.0-144.3)	0.95 (0.59-1.17)	
Sex-specific					0.81 (0.75-0.87)
≥1*	0.69	0.94	11.0 (6.9-17.3)	0.34 (0.23-0.48)	
≥2†	0.11	1.00	34.2 (4.4-263.2)	0.89 (0.46-1.11)	
<b>10-Item AUDIT</b>					
Standard					0.87 (0.84-0.91)
≥2	0.87	0.71	3.0 (2.5-3.7)	0.19 (0.13-0.31)	
≥3	0.70	0.86	4.9 (3.6-6.7)	0.35 (0.27-0.50)	
≥4	0.47	0.92	6.0 (3.8-9.3)	0.57 (0.43-0.76)	
≥5	0.35	0.98	21.2 (8.5-52.9)	0.66 (0.39-0.86)	
Sex-specific					0.89 (0.85-0.92)
≥2	0.89	0.71	3.0 (2.5-3.7)	0.16 (0.11-0.27)	
≥3	0.74	0.85	5.0 (3.7-6.7)	0.30 (0.23-0.44)	
≥4	0.57	0.92	7.0 (4.6-10.6)	0.47 (0.34-0.63)	
≥5	0.38	0.98	19.4 (8.4-44.6)	0.63 (0.38-0.82)	

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; AUDIT-C, the first 3 questions of the AUDIT; CI, confidence interval; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; LR, likelihood ratio; ROC, area under the receiver operating characteristic curve.

\*Greater than or equal to 1 indicates less than monthly, monthly, weekly, or daily or almost daily.

†Greater than or equal to 2 indicates monthly, weekly, or daily or almost daily.

### TEN-ITEM AUDIT

At identical cut points, the standard 10-item AUDIT was more sensitive than the standard AUDIT-C for identifying past-year hazardous drinking and/or DSM-IV alcohol abuse or dependence (Table 2), but the 10-item AUDIT had a slightly lower area under the ROC curve than the AUDIT-C (0.87 vs 0.91;  $P = .007$ ). The performance of the 10-item AUDIT was not meaningfully affected by the substitution of the sex-specific AUDIT question 3 (Table 2). As in a previous study,<sup>14</sup> the standard 10-item AUDIT was an effective screening test for active alcohol abuse or dependence with an area under the ROC curve of 0.90, but the AUDIT-C performed as well (Table 3).

### SELECTION OF SCREENING THRESHOLDS

Clinicians often choose a screening threshold that maximizes sensitivity and specificity (ie, the point nearest the left upper corner of the ROC curve), ideally where both sensitivity and specificity are greater than 0.80. Using such criteria, the optimal cut point for the standard and sex-specific AUDIT-C screen would be at least 2. However, an alternate approach has been proposed whereby the screening threshold would be varied in different settings on the basis of the prevalence of hazardous and problem drinking and the costs and benefits of screening in each setting.<sup>32</sup> **Table 4** shows the optimal cut points for

the 2 versions of the AUDIT-C, the sex-specific AUDIT question 3, and the standard 10-item AUDIT assuming different C/B ratios and prevalence rates. In our study population, we might assume a prevalence of past-year hazardous drinking and/or active DSM-IV alcohol abuse or dependence of 20%, a conservative estimate given that the interviewed population was older than the nonparticipants and that the prevalence was higher in younger women. We might further assume a C/B ratio of 0.5 for alcohol-screening questionnaires that assess only alcohol consumption and are therefore brief and unlikely to result in inappropriate diagnostic labeling of patients. Given such assumptions, the optimal cut point for the standard and sex-specific AUDIT-Cs would be at least 2 and 3, respectively. The optimal threshold for a positive screening test result for the single-item sex-specific AUDIT question 3 would be at least 1 (any response but never in the past year). However, in some settings with lower prevalence rates or higher C/B ratios for alcohol screening, higher cut points would be optimal (Table 4).

### COMMENT

To our knowledge, this is the first study to compare 2 promising brief alcohol-screening questionnaires, the AUDIT-C and AUDIT question 3, and the 10-item AUDIT from which they were derived, with diagnostic interviews in women. As in a previous study of the AUDIT-C

**Table 3. Performance of Screening Questionnaires for Detecting Active DSM-IV Alcohol Abuse or Dependence (n = 39)**

Questionnaire, Cut Point	Sensitivity	Specificity	Positive LR (95% CI)	Negative LR (95% CI)	ROC (95% CI)
<b>AUDIT-C</b>					
Standard					0.91 (0.88-0.95)
≥2	0.92	0.78	4.2 (3.4-5.2)	0.10 (0.06-0.27)	
≥3	0.69	0.89	6.3 (4.4-9.0)	0.35 (0.25-0.59)	
≥4	0.56	0.95	11.8 (6.9-20.2)	0.46 (0.32-0.73)	
Sex-specific					0.92 (0.87-0.96)
≥2	0.90	0.76	3.7 (3.0-4.6)	0.13 (0.08-0.32)	
≥3	0.80	0.87	6.1 (4.5-8.4)	0.24 (0.16-0.45)	
≥4	0.67	0.94	11.2 (7.0-18.0)	0.35 (0.24-0.60)	
<b>AUDIT Question 3 Alone</b>					
Standard					0.76 (0.66-0.85)
≥1*	0.59	0.92	7.2 (4.7-11.1)	0.45 (0.33-0.72)	
≥2†	0.10	0.99	18.2 (3.4-95.9)	0.90 (0.58-1.26)	
Sex-specific					0.86 (0.78-0.93)
≥1*	0.82	0.86	6.1 (4.5-8.2)	0.21 (0.14-0.41)	
≥2†	0.23	0.99	40.9 (9.2-182.4)	0.77 (0.40-1.11)	
<b>10-Item AUDIT</b>					
Standard					0.90 (0.85-0.95)
≥2	0.95	0.64	2.6 (2.3-3.1)	0.08 (0.03-0.24)	
≥3	0.77	0.79	3.6 (2.8-4.7)	0.29 (0.20-0.52)	
≥4	0.69	0.89	6.3 (4.4-9.0)	0.35 (0.25-0.59)	
≥5	0.62	0.97	18.2 (9.9-33.4)	0.40 (0.25-0.65)	
≥6	0.54	0.98	23.8 (11.3-50.2)	0.47 (0.28-0.75)	
Sex-specific					0.91 (0.86-0.96)
≥2	0.92	0.63	2.5 (2.1-2.9)	0.12 (0.06-0.30)	
≥3	0.87	0.78	4.0 (3.2-5.1)	0.16 (0.10-0.36)	
≥4	0.74	0.87	5.6 (4.1-7.7)	0.30 (0.21-0.53)	
≥5	0.62	0.96	13.6 (7.9-23.4)	0.40 (0.27-0.66)	
≥6	0.59	0.98	23.2 (11.6-46.5)	0.42 (0.25-0.68)	

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; AUDIT-C, the first 3 questions of the AUDIT; CI, confidence interval; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; LR, likelihood ratio; ROC, area under the receiver operating characteristic curve.

\*Greater than or equal to 1 indicates less than monthly, monthly, weekly, or daily or almost daily.

†Greater than or equal to 2 indicates monthly, weekly, or daily or almost daily.

**Table 4. Optimal Cut Points for Screening for Past-Year Hazardous Drinking and/or Active DSM-IV Alcohol Abuse or Dependence With Varying Prevalence Rates and Cost-Benefit Ratios for Alcohol Screening**

	Prevalence, %							
	Cost-Benefit Ratio of 1.0				Cost-Benefit Ratio of 0.5			
	10	15	20	25	10	15	20	25
Calculated ROC tangent slope at optimal cut point*	9.0	5.7	4.0	2.9	4.5	2.8	2.0	1.5
Screening instruments								
AUDIT-C, standard	≥4	≥3	≥3	≥3	≥3	≥3	≥2	≥2
AUDIT-C, sex-specific†	≥4	≥4	≥3	≥3	≥3	≥3	≥3	≥2
AUDIT question 3 alone, sex-specific‡	≥2	≥2	≥1	≥1	≥2	≥1	≥1	≥1
10-Item AUDIT, standard	≥7	≥7	≥6	≥5	≥6	≥4	≥3	≥3

Abbreviations: AUDIT, Alcohol Use Disorders Identification Test; AUDIT-C, the first 3 questions of the AUDIT; DSM-IV, Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition; ROC, area under the receiver operating characteristic curve.

\*Calculated from the Metz equation with the specified prevalence and cost-benefit ratio, as explained in the "Analyses" subsection of the "Methods" section.

†Indicates the sex-specific threshold for binge drinking (≥4 drinks/occasion).

‡Indicates the sex-specific threshold for binge drinking (≥4 drinks/occasion); ≥1 indicates less than monthly, monthly, weekly, or daily or almost daily; ≥2, monthly, weekly, or daily or almost daily.

in men,<sup>18</sup> the 3-item AUDIT-C performed as well as the standard 10-item AUDIT, and was an excellent brief screening test for identifying past-year hazardous drinking and/or active DSM-IV alcohol abuse or dependence in women. The optimal screening threshold for the standard AUDIT-C in women was a score of 2 or more points (sensitivity, 0.81; specificity, 0.86). The standard ver-

sion of AUDIT question 3, which asks about the frequency of drinking 6 or more drinks on an occasion, was a relatively insensitive (0.45) single-item screening test in women, in contrast to its excellent performance in men.<sup>18,24</sup>

A variation of AUDIT question 3 that asks about the frequency of drinking 4 or more drinks on an occasion

in the past year did not improve the overall performance of the AUDIT-C or the 10-item AUDIT, although it slightly increased the sensitivity of the AUDIT-C at each cut point. The largest advantage of the sex-specific version of AUDIT question 3 was that it markedly improved the sensitivity of AUDIT question 3 as a single-item screening test in women, ie, 0.69 for hazardous drinking or active alcohol use disorders, and 0.82 for active alcohol use disorders.

Several limitations of this study deserve emphasis. Women in the study were told that their health care providers would not see their responses. If patients report drinking practices more accurately on questionnaires than when queried by their providers, we could have inflated the sensitivity of screening questionnaires. However, a previous study of a female patient population suggested that a physician-administered alcohol-screening test was more sensitive than the same questions on a self-administered survey.<sup>53</sup> Since alcohol-screening questionnaires appear to be less sensitive in white than African American women,<sup>13,14</sup> this study may have underestimated the sensitivity of the AUDIT-C in populations with a higher percentage of African American subjects. Finally, recruited women were slightly older than other female VA patients seen at the VA Puget Sound Health Care System, and the extent to which female VA patients are representative of female patients outside the VA system is not known.

Despite these limitations, this study's design had important strengths. We evaluated the ability of screening questionnaires to identify hazardous drinking and alcohol use disorders, on the basis of in-depth interviews. We avoided spectrum and workup biases present in some previous studies of alcohol-screening questionnaires<sup>19</sup> and evaluated recruitment bias. Screening questions were embedded in a questionnaire addressing multiple health-related topics, mimicking actual practice, and the interviewers were not aware of patients' screening responses, avoiding interviewer bias. Unlike previous studies that used sensitivity to identify the optimal screening threshold or identified optimal screening thresholds at a single estimated prevalence and C/B ratio, we presented optimal cut points in populations with different prevalence rates and C/B estimates for alcohol screening. Our study population was similar to 2 national samples of female VA patients, suggesting that our findings are generalizable to other female VA patient populations.<sup>56,57</sup> Finally, the prevalence of active alcohol abuse or dependence among women in this study was almost identical to that of a large non-VA primary care study using the same interview and a similar comparison standard (9.9% vs 9.5%). The full 10-item AUDIT performed comparably overall in this study and the previous non-VA study,<sup>14</sup> although it was slightly less sensitive for alcohol use disorders at each cut point in the present study. Because we have no reason to believe that alcohol-screening questions should perform differently in female VA and non-VA populations, we suspect our findings are generalizable to other female patient populations with similar demographic characteristics. Based on previous studies, the AUDIT-C and AUDIT question 3 will likely be more sensitive in predominantly African American populations.

Although it is not surprising that the AUDIT-C identifies hazardous drinking, since it asks explicitly about alcohol consumption, an important finding of this study is that these 3 questions about alcohol consumption are effective screening tests for active alcohol use disorders. Moreover, the AUDIT-C is probably a stronger screening questionnaire than the commonly used CAGE questionnaire in women. We did not evaluate the CAGE questionnaire because it has a low sensitivity for identifying active alcohol abuse or dependence in white and Hispanic women (0.21-0.46)<sup>14,58</sup> and does not screen for hazardous drinking.<sup>13</sup> However, previous research has demonstrated that the 10-item AUDIT has a higher area under the ROC curve than the CAGE questionnaire for identification of active alcohol use disorders in women,<sup>14</sup> and the AUDIT-C performed as well as the 10-item AUDIT for identification of active alcohol abuse or dependence in the present study. Furthermore, a Belgian study that evaluated the AUDIT-C and CAGE questionnaires in a single population of women, compared with a diagnosis of active alcohol abuse or dependence based on self-administered questionnaires,<sup>20</sup> found that the AUDIT-C had a sensitivity of 0.50 and specificity of 0.93 at the lowest reported cut point ( $\geq 5$ ), compared with 0.37 and 0.97, respectively, for the CAGE using a cut point of at least 2, and 0.54 and 0.92, respectively, for the CAGE using a cut point of at least 1. The area under the ROC curve for the AUDIT-C was higher (0.82; 95% CI, 0.80-0.85) than that for the CAGE (0.76; 95% CI, 0.73-0.79),<sup>20</sup> suggesting that the AUDIT-C would have been more sensitive with adequate specificity at lower cut points.

Although these data suggest to us that the AUDIT-C is the optimal alcohol-screening questionnaire for inclusion on health questionnaires or standardized interviews by clinical support staff, the response options and scoring may make it cumbersome for physicians to use during interviews. Therefore, we believe that physicians should learn a sex-specific question about binge drinking for use when taking medical histories from women. The sex-specific version of AUDIT question 3 was more sensitive for alcohol use disorders among women in the present study (0.82) than the CAGE questionnaire was among women in a recent large primary care study (0.21-0.63), despite the fact that the 10-item AUDIT (cut point,  $\geq 5$ ) was less sensitive in the present study (0.62) than in the latter study (0.70-0.78).<sup>14</sup> A previous study of a similar sex-specific question about binge drinking, "When was the last time you had more than 4 drinks in 1 day?" has also been shown to be an effective screening test for active alcohol use disorders in women.<sup>25</sup> The sex-specific AUDIT question 3 was also an adequate screening test for hazardous drinking in addition to active alcohol abuse or dependence, unlike the CAGE questionnaire in previous studies of men.<sup>24</sup>

## CONCLUSIONS

Despite the strengths of the AUDIT-C and AUDIT question 3, research validating these screening tests in other populations of men and women and directly comparing them with the CAGE will be needed. Clinicians and ad-

ministrators in the United States have become familiar with the CAGE questionnaire and may resist switching to the AUDIT-C without studies of non-VA populations. Some may resist using the AUDIT-C if they are unaware that questions about binge drinking are effective screening tests for identifying alcohol use disorders, and if they recall that global consumption questions such as "How much do you drink?" are relatively insensitive.<sup>1,24,59</sup>

Meanwhile, we believe the AUDIT-C is the optimal brief questionnaire for routine alcohol screening in medical settings because it performs at least as well as the commonly used CAGE questionnaire for identification of active alcohol abuse or dependence in women as well as men and also screens for hazardous drinking.<sup>18,20</sup> For women, we prefer the sex-specific AUDIT-C, asking about the frequency of drinking 4 or more drinks on an occasion, because it is more likely than the standard version to elicit reports of drinking above recommended levels (>7 drinks a week or  $\geq 4$  drinks on an occasion for women), and we suspect clinicians will be more comfortable addressing alcohol use when patients explicitly report hazardous drinking. A screening threshold of at least 2 or 3 can be used for the sex-specific AUDIT-C, depending on the setting (Table 4). When a single instrument is desired for men and women, the standard AUDIT-C can be used with a cut point of at least 2 for women. A sex-specific question about binge drinking, such as the modified AUDIT question 3, may be more practical to incorporate into physician interviews, although its maximum sensitivity of 0.69 may be lower than desired in some populations. Patients with positive screening results on the AUDIT-C or the sex-specific AUDIT question 3 will include a spectrum of drinkers, and providers' responses to patients with positive screening results should vary depending on the severity of drinking problems. Patients who appear to have only hazardous drinking can be offered education and advice regarding recommended drinking limits, whereas those with alcohol dependence will likely benefit from advice to abstain and referral to alcohol treatment.

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Corresponding author: Katharine A. Bradley, MD, MPH, Health Services Research and Development Service (Mail Stop 152), Veterans Affairs Puget Sound Health Care System, 1660 S Columbian Way, Seattle, WA 98108 (e-mail: willi@u.washington.edu).

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