Confirmatory Factor Analyses of the Alcohol Use Disorders Identification Test (AUDIT) among Adolescents Treated in Emergency Departments*

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ABSTRACT. Objective: The Alcohol Use Disorders Identification Test (AUDIT) is a 10-item instrument designed by the World Health Organization to assess problematic drinking. The objective of this study was to conduct confirmatory factor analysis of the AUDIT in a sample of adolescents and young adults who were treated in emergency departments. Method: Adolescents and young adults (N = 103, 55 males), ranging in age from 12 to 20.9 years (mean [SD] age = 17.3 [2.1]), completed the AUDIT. Confirmatory factor analyses were conducted using LISREL 8.20 software to test the one-factor, two-factor and three-factor solutions for the AUDIT reported in the literature. Results: Goodness-of-fit indices indicated that a correlated two-factor solution, consisting of a consumption factor and an alcohol-related-problems factor, provides the best fit to the data. The three-factor solution fits the data equally well, but Factor 2 (dependency) and Factor 3 (problems) correlate 1.00. The one-factor solution did not provide a good fit to the data. Conclusions: Our findings support those of others who have reported that the AUDIT assesses a consumption factor and an alcohol-related problems factor among primary care patients at risk for problematic drinking behavior. (J Stud Alcohol 62: 838-842, 2001)

A DOLESCENTS TREATED in emergency departments (EDs) are at higher risk for developing alcohol use disorders compared with adolescents in the general population. Chung and colleagues (2000) reported a DSM-IV (American Psychiatric Association, 1994) alcohol use disorder prevalence rate of 18% among an ED-treated sample of 13- to 19-year-old adolescents. Lewinsohn and colleagues (1996) found a prevalence rate of about 6% among a community sample of 14- to 18-year-old high school students. Screening in EDs allows for detection of hazardous drinking among adolescents and young adults who are at higher risk for alcohol use disorders and, hence, could enhance primary and secondary prevention efforts in this population.

The Alcohol Use Disorders Identification Test (AUDIT) (Babor et al., 1989; Saunders et al., 1993) is a 10-item questionnaire that was designed to assess three related constructs: alcohol consumption, drinking-related problems and alcohol dependence. The AUDIT is in widespread use (Allen et al., 1997) and has been found to possess excellent reliability and validity as a screening instrument for potentially hazardous drinking among adults in medical settings (Bohn et al., 1995).

The performance of alcohol screening instruments varies greatly as a function of the sample and setting in which they are used (Cherpitel, 1995; Maisto et al., 1995). Therefore, it is critical to determine the construct validity of screening instruments within specific populations and settings. Confirmatory factor analysis (CFA) assesses whether an instrument is measuring the constructs it was originally intended to measure, and allows for a comparison with constructs that were found using the same instrument in other populations and settings. Such studies provide information about the interpretability of findings and any limitations of the instrument.

Studies of the factor structure of the AUDIT in adult samples have supported a one-factor solution (Skipsy et al., 1997) as well as a two-factor solution (Karno et al., 2000; Maisto et al., 2000). The only previous study of the factor structure of the AUDIT in an adolescent emergency department sample (Chung et al., submitted) found evidence for a two-factor solution, reflecting alcohol consumption and alcohol problems; however, the Chung and colleagues study used principal components analysis rather than a confirmatory structural equation analysis. The current study presents a CFA of the AUDIT among 103 ED-treated adolescents and young adults from the Mid-Atlantic region of the country.

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Method

Procedure

This protocol was approved by the Institutional Review Board of the University of Pittsburgh. The participating EDs are a pediatric emergency department and a university-affiliated general hospital. Both are Level-1 trauma centers. Inclusion criteria for the study consisted of (1) age 12 to 20 years (inclusive); (2) Glasgow Coma Score = 15 (i.e., no serious head injury; Jennet and Bond, 1975); (3) patient accompanied by parent or legal guardian (for those under 18 years of age), and (4) able to read and complete a self-report questionnaire. Patients were excluded if the medical staff considered them to be too seriously ill or too severely injured to approach. The medical staff was not informed of any results and these research data were not entered in the medical record.

After obtaining informed consent, a 29-item self-report questionnaire was administered in private to the adolescent. The AUDIT items were presented first in the questionnaire in the same order as proposed by the AUDIT developers. Two other alcohol screening instruments, the CAGE (Ewing, 1984) and the TWEAK (Russell, 1994) are also included in the questionnaire. One TWEAK item that assesses tolerance was placed between AUDIT Item 2 (number of drinks when drinking) and AUDIT Item 3 (occasions drinking six or more drinks).

Sample

Of the 359 adolescents and young adults who were approached, 282 (78.5%) participated in the study. Whites were more likely to participate compared with blacks or patients of other races ($\chi^2 = 7.0, 2$ df, $p < .04$) and injured patients were more likely to participate compared with those being treated for illness ($\chi^2 = 14.2, 1$ df, $p < .001$). A majority (175; 62%) indicated that they had never drunk alcohol, and four patients (1.5%) either did not complete the AUDIT or provided contradictory information on the scale (e.g., entered two answers for the same item). This report is based on the 103 participants (36.5%; 55 males) who indicated that they used alcohol and who provided usable data on the AUDIT scale. The age range for these participants was 12.2-20.9 years (mean [SD] = 17.5 [2.1]). The sample was 80% white, 14% black and 6% other.

Data analytic procedures

Our objective was to test the one-, two- and three-factor solutions in our adolescent/young adult sample, using confirmatory factor analyses (CFA). A maximum likelihood analysis was performed using LISREL 8.20 (Jöreskog and Sörbom, 1993). Consistent with recommendations on reporting the results of structural equation models (Hoyle and Panter, 1995) we report several different goodness-of-fit statistics: the $\chi^2$ statistic, the goodness-of-fit index (GFI), the standardized root mean square (SRMR) and the root mean square error of approximation (RMSEA) as indicators of absolute fit, and the Non-Normed Fit Index (NNFI) and Comparative Fit Index (CFI) as indicators of incremental fit to the data. Hu and Bentler (1999) suggest using a combinational strategy for assessing model fit and that a CFI $\geq 0.95$, an SRMR $\leq 0.08$ and an RMSEA $\leq 0.06$ result in low Type-II error rates while maintaining acceptable levels of Type-I error. The statistical significance of item loadings on the underlying factors was determined by Critical Ratio (CR) tests.

Results

The range of scores for the AUDIT in this sample is from 1 to 32, and the mean (SD) total scale score is 7.74 (7.14). Internal consistency for the total scale was high; Cronbach’s $\alpha$ equaled 0.86 (Cronbach, 1951), which is midrange for the alpha reliabilities cited in other investigations ($\alpha = 0.75$-0.94; Allen et al., 1997).

We first tested for the one-factor solution found by Skipsey and colleagues (1997), by allowing all 10 AUDIT items to load on a single factor. This first analysis produced a covariance matrix that was nonpositive definite, which was inconsistent with determining the viability of the one-factor solution. Item 9 (“injury as a result of alcohol use”) had no covariance with Item 7 (“feeling guilty or remorse about drinking”) and a highly negative covariance with Item 8 (“failure to remember after drinking”) (covariance = -2259.0). When Item 9 was removed from subsequent analyses, the data analysis proceeded without problem. Table 1 displays the nine-item correlation matrix, which was analyzed for all the CFAs that were conducted.

The one-factor solution did not provide a good fit to the data for the nine-item AUDIT ($\chi^2 = 111.69, 27$ df, $p < .001$; GFI = 0.75; NNFI = 0.76; CFI = 0.80, SRMR = 0.11; RMSEA = 0.21). The chi-square measure of fit reflects a

Table 1. Correlations among the nine AUDIT items ($N = 103$)

<table>
<thead>
<tr>
<th>Item</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>0.659</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>0.752</td>
<td>0.785</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>0.458</td>
<td>0.299</td>
<td>0.471</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>0.496</td>
<td>0.428</td>
<td>0.612</td>
<td>0.460</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>0.346</td>
<td>0.217</td>
<td>0.390</td>
<td>0.526</td>
<td>0.467</td>
<td>1.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>0.340</td>
<td>0.319</td>
<td>0.458</td>
<td>0.332</td>
<td>0.485</td>
<td>0.392</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>0.411</td>
<td>0.338</td>
<td>0.506</td>
<td>0.578</td>
<td>0.374</td>
<td>0.494</td>
<td>0.314</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>0.307</td>
<td>0.252</td>
<td>0.350</td>
<td>0.436</td>
<td>0.425</td>
<td>0.608</td>
<td>0.395</td>
<td>0.358</td>
<td>1.000</td>
</tr>
</tbody>
</table>

Note: Item 9 was removed because of its contribution to a nonpositive definite matrix.
Table 2. Standardized factor loadings for the one-, two- and three-factor models for the AUDIT scale (N = 103)

<table>
<thead>
<tr>
<th></th>
<th>One-factor solution loadings</th>
<th>Two-factor solution loadings</th>
<th>Three-factor solution loadings</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consumption</td>
<td>Problems</td>
<td>Consumption</td>
</tr>
<tr>
<td>1. Frequency of drinking</td>
<td>.79</td>
<td>.77</td>
<td>.77</td>
</tr>
<tr>
<td>2. How many drinks do you have</td>
<td>.77</td>
<td>.80</td>
<td>.65</td>
</tr>
<tr>
<td>3. How often do you have six or more drinks</td>
<td>.57</td>
<td>.64</td>
<td>.51</td>
</tr>
<tr>
<td>4. How often could you not stop drinking</td>
<td>.47</td>
<td>.65</td>
<td>.51</td>
</tr>
<tr>
<td>5. How often did you do what you were supposed to do</td>
<td>.49</td>
<td>.64</td>
<td>.51</td>
</tr>
<tr>
<td>6. How often did you need a drink to get going</td>
<td>.51</td>
<td>.60</td>
<td>.51</td>
</tr>
<tr>
<td>7. How often did you feel guilt or remorse about drinking</td>
<td>.57</td>
<td>.60</td>
<td>.51</td>
</tr>
<tr>
<td>8. How often could you not remember</td>
<td>.45</td>
<td>.57</td>
<td>.49</td>
</tr>
<tr>
<td>9. How often did a friend, family member or health care worker show concern</td>
<td>.45</td>
<td>.57</td>
<td>.49</td>
</tr>
</tbody>
</table>

* r = .75; a = consumption/dependence; r = .76; consumption/problems; r = .61; dependence/problems; r = 1.00.

Note: The first indicator for each factor was fixed at 1.00 in each case to identify the factor. All other factor loadings are statistically significant by the Critical Ratio test (r > 2.0).

A significant departure from the hypothesized model, and the goodness-of-fit indices do not indicate an adequate fit to the data. Table 2 displays the factor loadings for the one factor model.

We next tested the fit of the original AUDIT three-factor solution. In this solution, the first three items load on a “consumption” factor, items 4-6 load on a “dependence” factor and Items 7-8 and 10 load on a “problems” factor. This first three-factor analysis did not allow for correlated error terms and did not provide a very good fit to the data (χ² = 45.23, 24 df, p < .006; GFI = .91; NNFI = .93; CFI = .95; SRMR = .07; RMSEA = .09). The analysis revealed a modification index greater than 5.0 for the residual covariance between Items 6 and 10, suggesting that allowing these error terms to correlate would result in a significant decrease in the chi-square statistic (p < .05) and a better fit of the model to the data. When the error variances for these items were allowed to correlate in the subsequent analysis, there was a better fit to the data (χ² = 26.35, 22 df, p < .24; GFI = .95; NNFI = .98; CFI = .99; SRMR = .05; RMSEA = .04). However, there was also a perfect correlation (1.00) between the dependence and problems factors in this model, suggesting that these are actually a single factor. Table 2 displays the factor loadings for the three-factor model that allowed for correlated error variances.

The two-factor solution (Karno et al., 2000) specifies that the first three items load on a consumption factor and that the last six items (minus Item 9) load on a problems factor. The initial solution did not include correlated error terms and did not provide a good fit to the data (χ² = 48.08, 26 df, p < .006; GFI = .90; NNFI = .93; CFI = .95; SRMR = .07; RMSEA = .09). Again, we found modification indices greater than 5.0 between the error variances for Item 4 and Item 8, and between Item 6 and Item 10. As a result, another CFA that included these two correlated error terms was conducted. This solution provided the best fit to the data (χ² = 29.42, 24 df, p = .21; GFI = .94; NNFI = .98; CFI = .99; SRMR = .05; RMSEA = .04).

There was a nonsignificant discrepancy between the predicted and observed correlation matrices, and the incremental measures of goodness-of-fit are well within the cutoffs suggested by Hu and Bentler (1999). There was a significant improvement in fit between the first two-factor model with uncorrelated errors and the final two-factor model that allowed for correlated errors (difference χ² = 18.66, 2 df, p < .001; see Table 2 for factor loadings and factor correlations for the two-factor model that included correlated errors).

Discussion

The results of the current study provide additional evidence supporting a correlated two-factor solution for the AUDIT when used with adolescents and young adults who have been treated in emergency departments. The correlated two-factor solution identified in this study is the same as that found by Chung and colleagues (submitted) in their study of ED-treated adolescents. Maisto and colleagues (2000) found a two-factor solution in an adult sample after they dropped Item 10 (others concerned) due to its equivalent loadings on both factors. The factor structure of the AUDIT for our adolescent/youth adult sample is the same as that reported by Karno and colleagues (2000), who found that Item 9 (self or other alcohol-related injury) did not load on either factor. Our own CFA could not be conducted so long as Item 9 remained in the matrix. The item-total correlation for Item 9 was the lowest of all items for our sample (r = .42) and its mean of .83 was the largest non-consumption item for our sample; the standard deviation for this item was the largest of all items (SD = 1.54). This suggests wide variation in participant response. In fact, 77 participants denied being injured as a result of drinking although 25 others reported sustaining an alcohol-related injury within the last year.
Adolescents and young adults in this sample report higher levels of consumption compared with reports of problems associated with the use of alcohol. This is evident in higher scores on the first three items compared with the last six items (data not shown), as well as the higher factor loadings for these items compared with the items that measure alcohol-related problems (see Table 2). This suggests that the younger drinkers studied here did not experience many alcohol-related problems, although they may be vulnerable to problems later in life. The sample in our study is young, however, and most of the participants who report excessive consumption are likely to "mature out" as they age.

Skipsey and colleagues' (1997) findings of a unidimensional AUDIT factor structure may be due to the tendency for their sample of adult substance abusers to score high on all constructs assessed by the instrument. The present findings of a two-factor structure in this young sample are validated by reports of other investigators. White (1987) and Smith et al. (1995) report a two-dimensional structure reflecting intensity of alcohol intake and alcohol-related problems in general population samples of adolescents. Bailey and Rachal (1993) found a use factor, a drinking problems factor, and a dependency factor in a large sample study of high school students, but the dependency factor accounted for just 2% of the variance. Taken together, the current findings and others cited in the literature on the factor structure of the AUDIT, as well as research on adolescent problem drinking, indicate that consumption patterns and frequency of alcohol-related problems are the most important domains to explore when screening for hazardous alcohol use among young alcohol users.

There are several limitations to the current findings. Whereas the current sample size is small, it is not clear what sample size is necessary to conduct a valid factor analysis. The general consensus is that, as sample size increases, standard errors become smaller and the resulting factor analyses produce increasingly stable solutions (MacCallum et al., 1999). The sample size limitation is attenuated somewhat in the current CFA since the statistics suggested by Hu and Bentler (1999) for assessing model fit indicate a good fit for the two-factor and the three-factor solutions that allowed for correlated errors.

The proportion of minorities in the sample is small but it is representative of the city in which the data were collected, and this precluded testing the models by race. A further limitation is that the AUDIT was used as part of a larger questionnaire that included other screening instruments. Brief screening instruments may perform differently based on their ordering in questionnaires that contain more than one screening instrument (Cherpitel, 1997).

Last, our findings may not generalize beyond the population of late adolescent alcohol users who are treated in emergency departments. In order to provide a more definitive answer concerning the constructs that are assessed by the AUDIT among adolescents, future psychometric research on the AUDIT should include larger, more heterogeneous samples of adolescents.

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References


