

Validation of the Alcohol Use Disorders Identification Test in university students: AUDIT and AUDIT-C

Validación del test para la identificación de trastornos por uso de alcohol en población universitaria: AUDIT y AUDIT-C

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Abstract

The aim of this study was to determine the psychometric properties of the Alcohol Use Disorders Identification Test (AUDIT and AUDIT-C) in order to detect problems related to the consumption of alcohol in the university population. The sample consisted of 1309 students. A Weekly Alcohol Consumption Diary was used as a gold standard; Cronbach's Alpha, the Kappa index, Spearman's correlation coefficient and exploratory factor analysis were applied for diagnostic reliability and validity, with ROC curves used to establish the different cut-off points. Binge Drinking (BD) episodes were found in 3.9% of men and 4.0% of women with otherwise low-risk drinking patterns. AUDIT identified 20.1% as high-risk drinkers and 6.4% as drinkers with physical-psychological problems and probable alcohol dependence. Cronbach's alpha of 0.75 demonstrates good internal consistency. The best cut-off points for high-risk drinking students were 8 for males and 6 for females. As for problem drinkers and probable ADS, 13 was the best cut-off point for both sexes. In relation to AUDIT-C, 5 and 4 were the best cut-off points for males and females with high-risk patterns, respectively. The criterion validity of AUDIT and AUDIT-C to detect binge drinking episodes was found to have a moderate K value. The results obtained show that AUDIT has good psychometric properties to detect early alcohol abuse disorders in university students; however, it is recommended that the cut-off point be reduced to 8 in men. AUDIT-C improves its predictive value by raising the cut-off point by one unit. Items 2 and 3 should be reviewed to increase its predictive value for BD. *Keywords:* Alcohol-Related Disorders/diagnosis*, Psychometrics/methods*, University students, AUDIT, AUDIT-C.

Resumen

El objetivo de este trabajo fue determinar las propiedades psicométricas de los cuestionarios Alcohol Use Disorders Identification Test (AUDIT y AUDIT-C) para la detección de problemas por consumo de alcohol en universitarios. Participaron 1309 estudiantes, utilizando el Diario de consumo semanal como patrón de referencia y para el análisis de fiabilidad y validez el alfa de Cronbach, análisis exploratorio, índice kappa, coeficiente de correlación de Spearman y curvas ROC para los diferentes puntos de corte. Un 3,9% de hombres y un 4% de mujeres con consumo de riesgo bajo presentaba consumo intensivo de alcohol (BD). AUDIT identificó un 20,1% de Bebedor de riesgo y un 6,4% de Bebedor con problemas físico-psíquicos y probable dependencia alcohólica. El instrumento presentó un alfa-Cronbach de 0,75 demostrando buena consistencia interna. Los puntos de corte óptimos fueron ocho para Bebedor de riesgo en hombres y seis para mujeres; trece puntos para Bebedor con problemas físico-psíquicos y probable dependencia alcohólica en ambos sexos; con AUDIT-C, fueron para Consumo de riesgo cinco para hombres y cuatro para mujeres. La validez de criterio para detectar consumo intensivo de alcohol (BD) con ambas versiones presentó un valor K moderado. Los resultados indican que AUDIT cuenta con adecuadas propiedades psicométricas para detectar precozmente problemas de consumo de alcohol en universitarios, recomendándose reducir su punto de corte a ocho en varones. El AUDIT-C mejora su poder predictivo aumentando en una unidad el punto de corte. Se recomienda revisar los ítems 2 y 3 para aumentar el valor predictivo del BD. *Palabras clave:* Trastornos relacionados con el alcohol, Psicometría, Universitarios, AUDIT, AUDIT-C.

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AUDIT (Alcohol Use Disorders Identification Test) is a self-administered questionnaire which is short, easy to use and flexible. It is consistent with CIE-10 definitions of alcohol consumption and dependence and assesses consumption over the previous year, thereby generating information which can be useful in providing feedback for those taking the questionnaire. As one of the most extensively used screening tests worldwide, the WHO recommends its systematic use in health care and other settings (Rosón, 2008).

The Spanish version has been validated in health care settings (Martínez 1996; Rubio, Bermejo, Caballero, & Santo-Domingo, 1998) and even in a university student population (Adewuya, 2005; Kokotailo et al., 2004), but as this was in different cultural contexts and with different terminology it is difficult to know whether its psychometric properties make it a suitable instrument for the Spanish university population.

AUDIT consists of ten questions, the first three of which refer to high-risk consumption, with the following three exploring potential dependence symptoms, and the final four focusing on hazardous consumption. Depending on the cut-off points, the total score enables the identification of risky consumption patterns and possible alcohol dependence. In the Spanish validation, (Rubio et al., 1998), the cut-off point for high-risk consumption was set at 9 or above for men and 6 or above for women. A short version, AUDIT-C, which uses the first three questions, is sensitive and specific enough to be a valid tool for identifying high-risk consumption.

Given the changes in alcohol consumption patterns among university students, there is great interest in developing an instrument to detect these; indeed, various studies have confirmed differences in drinking patterns among young people depending on educational background, so for example while non-university students drink more often (Dawson, Grant, Stinson, & Chou, 2004; Kypri, & McAnally, 2005), university students tend to binge-drink more (O'Malley & Johnston, 2002). *Binge drinking (BD)* is one of the major high-risk behaviors among university students (Cortés, Espejo, & Giménez, 2008; Kypri et al., 2009; Wicki, Kuntsche, & Gmel, 2010), which can provoke short- and long-term problems. Recent research among young binge drinkers shows physiological changes in parameters such as blood pressure and state anxiety immediately on consumption (Vinader-Caerols, Monleón, & Parra, 2014), and structural changes in white and gray matter, neuronal hyper/hypoactivation, and cognitive impairment in memory, attention and execution associated with a pattern of binge drinking over time (López-Caneda et al., 2014). While some international controversy surrounds the definition of binge drinking, the last report in 2001 by the Spanish Observatory on Drugs and Drug Addiction defines it as drinking which takes place in short sittings of a few hours, mainly at the weekend, in peer groups and with a low perception of risk. The prevalence of

BD among young people aged 20 to 29 is 15.2%, according to the EDADES study of 2011/12.

For these reasons, it is important to be able to rely on instruments which allow early detection and point towards preventive measures, hence the interest in discovering the sensitivity, specificity and predictive power of AUDIT and AUDIT-C among the university population, and in determining the utility and validity of these tests.

The hypotheses considered in this study are firstly that the AUDIT questionnaire is a good tool for the early detection of drinking problems and discrimination between low-, moderate- and high-risk alcohol use, and secondly that the short version (AUDIT-C) is of sufficient reliability and diagnostic validity among the population of university students with high-risk consumption.

The aim of the study is to determine the psychometric properties of AUDIT and AUDIT-C for the detection of problems linked to alcohol consumption at university.

Method

Participants

The questionnaire was completed by a total of 1352 students selected by proportional sampling, of which 43 were rejected for not meeting basic quality criteria. This left a sample of 1309 (59.1% women) with an average age of 21.78 (SD ± 4,45) and an age range of 18 to 65. The expected frequency of consumption in the previous month was considered to be 63%, with an absolute margin of error of 2.5% (Committee for Equality and Social Welfare, Government of Andalusia, 2009)

Instruments

All participants completed an anonymous self-report with socio-demographic variables, the AUDIT questionnaire, and the weekly alcohol consumption diary.

AUDIT is a self-administered questionnaire with a scoring range of 0-40 points. The first eight questions are scored from 0 to 4, and questions nine and ten with 0, 2 and 4 points. The cut-off points proposed by Rosón (2008) identify three population subtypes: *low-risk drinker* (with cut-offs of 0-7 for men, 0-5 for women), *high-risk drinker* (cut-offs 8-12 and 6-12), and *drinker with physical-psychological problems and probable alcohol dependence (ADS)* (cut-off 13 for both). The first three questions of this test make up AUDIT-C, in which scores of 4 or higher in men (Bush, Kivlahan, McDonell, Fihn, & Bradley, 1998) and 3 or higher in women (Bradley et al., 2003) are considered to represent high-risk drinking.

The weekly alcohol consumption diary is a record of Standard Drink Units (SDU) consumed at different times or occasions throughout the day (morning, aperitif, lunchtime, afternoon, evening meal, night). Following Rodríguez-Martos (2007a), three categories were considered: *low-risk consumption* (SDUs ≤ 21 and ≤ 14 for men and wo-

men respectively), *moderate-risk consumption* (22-27 and 15-16 SDUs) and *high-risk consumption* (≥ 28 and 17 SDUs). Special attention was paid to BD as a separate category, considered to be the consumption of five or more SDUs in a single sitting, which could represent problematic drinking behavior (Rodríguez-Martos, 2007b).

Procedures

In order to investigate the validity and internal structure of the AUDIT and AUDIT-C scores in this population, a weekly alcohol consumption diary was used as a 'gold standard'. The diary is not only a record of the quantity, frequency, typology of drinks consumed and of drinking patterns but also enables, through the evaluation of these data, the identification and classification of at-risk populations such as binge drinkers.

Data analysis

For the reliability and validity analyses of AUDIT version 20 of the SPSS and FACTOR 9.2 were used.

Reliability. Cronbach's alpha was used as a measure of internal consistency. To determine the correlation between the different sub-scales and the global score, the Spearman correlation coefficient was applied.

To assess *content validity*, the mean scores of two students groups with significantly different alcohol consumption (moderate- and high-risk) were compared. Similarly, the

scores on each AUDIT item were compared to the mean scores obtained in the weekly consumption diary for each of the three low-, medium- and high-risk groups of students.

Internal structure validity was investigated by means of exploratory factor analysis (EFA) to assess underlying dimensionality with psychological value, bearing in mind that the original version of AUDIT already has three dimensions or factors. FACTOR 9.2 (Lorenzo-Seva & Ferrando, 2006) was used to check whether the structure obtained in this university population matched the theoretical structure. *Minimum Average Partial (MAP)* (Velicer, 1976) was applied as the method for determining the number of dimensions; *Unweighted Least Squares (ULS)* with Promin rotation was used for extraction; and the Simplimax rotation was used as the most efficient method for obtaining the most suitable cut-off points.

We carried out a multivariate analysis of variance (MANOVA) of the responses to the AUDIT in the three categories of risk established by the weekly diary of alcohol consumption (in SDUs).

The *criterion* or *diagnostic validity* of the AUDIT and AUDIT-C questionnaire scores was assessed on the basis of values obtained with the weekly consumption diary used as a gold standard. The sensitivity and specificity of each item was calculated for the three categories of risk consumption (low, moderate and high) and for BD. ROC curves were ob-

Table 1. Alcohol consumption patterns among university students (total population and drinkers), by sex.

Weekly consumption of alcohol and consumption patterns			Men	Women	Total
Total population (N=1309)	Consumption last week	% (n)	73,1 (535)	64,6 (774)	68,1 (1309)
	SDUs last week Mean (SD)	Monday to Wednesday	1,60 (3,7)	0,52 (1,9)***	1,01 (2,9)
		Thursday	1,25 (3,0)	0,79 (2,1)	0,98 (2,5)
		Friday to Sunday	8,14 (9,3)	5,30 (6,3)**	6,29 (8,0)
		Total weekly	10,99 (12,6)	6,60 (8,1)***	8,39 (10,4)
	Weekly consumption pattern (%)	Low-risk consumption ^a	77,2	77,4	77,3
		Moderate-risk consumption ^b	15,0	16,9	16,1
		High-risk consumption ^c	7,9	5,7	6,6
	Binge drinking	≥ 5 SDUs per sitting	38,3	32,7***	35,0
	Drinkers (n=891)	Consumption last week	% (n)	73,1 (391)	64,6 (500)
SDUs last week Mean (SD)		Monday to Wednesday	2,18 (4,1)	0,80 (2,3)***	1,41 (3,3)
		Thursday	1,71 (3,4)	1,22 (2,6)	1,44 (2,9)
		Friday to Sunday	11,13 (9,2)	8,20 (6,2)*	9,49 (7,8)
		Total weekly	15,03 (12,5)	10,22 (8,0)***	12,33 (10,5)
Weekly consumption pattern (%)		Low-risk consumption ^a	68,8	65,0	66,7
		Moderate-risk consumption ^b	20,5	26,2	23,7
		High-risk consumption ^c	10,7	8,8	9,7
Binge drinking		≥ 5 SDUs per sitting	52,4	50,6***	51,4

Note. SDU (Standard Drink Unit); SD (Standard Deviation). ^a ≤ 21 SDU men and ≤ 14 SDU women. ^b 22-27 SDU men and 15-16 SDU women. ^c ≥ 28 SDU men and ≥ 17 SDU women. * $p = .018$; ** $p = .002$; *** $p = .000$.

tained and various cut-off points were considered for identifying optimal sensitivity and specificity. The efficiency of these points was evaluated with the Youden index, and the concordance between observations was established with the Kappa index, using Altman criteria for classification. To evaluate the criterion validity of the AUDIT and AUDIT-C scores for the diagnosis of BD, a benchmark was established of 5 or more SDUs consumed in a single sitting.

Results

Alcohol consumption patterns

The weekly consumption diary shows that 68.1% of students drank alcohol during the previous week, with men be-

Table 2. Problems with alcohol consumption by sex according to AUDIT (total population and drinkers).

AUDIT		Men	Women	Total
		N (%)	N (%)	N (%)
Total population (N=1309)	Low-risk drinkera	390 (72,9)	572 (73,9)	962 (73,5)
	High-risk drinkerb	101 (18,9)	162 (20,9)	263 (20,1)
	Drinker with probable ADSc	44 (8,2)	40 (5,2)	84 (6,4)
	Total	535 (100,0)	774 (100,0)	1309 (100,0)
Drinkers (n=891)	Low-risk drinkera	249 (63,7)	304 (60,8)	553 (62,1)
	High-risk drinkerb	98 (25,1)	156 (31,2)	254 (28,5)
	Drinker with probable ADSc	44 (11,3)	40 (8,0)	84 (9,4)
	Total	391 (100,0)	500 (100,0)	891 (100,0)

Note. ADS (Alcohol Dependence Syndrome). ^a ≤ 7 men and ≤ 5 women. ^b 8-12 men and 6-12 women. ^c ≥ 13 men and women.

ing more frequent drinkers (73.1%) than women (64.6%). Taking only those students who had consumed alcohol in the previous week (n=891), the prevalence of *moderate-risk consumption* was 23.7%, while 9.7% was *high-risk*. The average weekly intake was 15.03 SDUs among men, with significantly lower values (p = .000) among women (10.22 SDUs per week) (Table 1).

BD was found independently of whether weekly consumption patterns were low-, moderate- or high-risk; for example 3.9% of men and 4.0% of women had binge drinking episodes despite their consumption being considered *low-risk*.

AUDIT figures show that a quarter of the sample (26.5%) had alcohol consumption problems, of which 20.1% were *high-risk drinkers* and 6.4% were *drinkers with physical-psychological problems and probable ADS*. Among those who had drunk alcohol in the last week, these figures rose to 28.5% and 9.4% respectively (Table 2).

With regard to AUDIT-C, more than half of the drinkers (63.2%) reached the cut-off for *high-risk consumption*, with a predominance (p = .000) of women (36.4%, compared to 26.8% men).

Reliability study

Internal consistency. The internal consistency (Cronbach's alpha) of AUDIT was 0.75; by domain, the sub-scale *high-risk consumption* yielded a value of 0.83, with 0.79 obtained for *dependence symptoms* and 0.75 for *hazardous consumption*.

The highest values were obtained by questions 1, 2 and 3, which make up the *high-risk consumption* domain, exploring the frequency and quantity of alcohol consumed. Conversely, items 5, 6, 9 and 10 yielded the lowest scores. These questions deal with information regarding dependence symptoms, injuries suffered as a result of drinking, and the worry of others about the amount of alcohol drunk by the subject (Table 3).

Table 3. Correlation of AUDIT item scores with scale total.

AUDIT	Media	SD	Inter-element correlation matrix	Inter-element co-variance matrix	Cronbach's alpha if item deleted
Item 1	1,68	1,001	0,706	2,960	0,709
Item 2	0,64	0,856	0,662	2,372	0,718
Item 3	0,66	0,938	0,811	3,187	0,700
Item 4	0,29	0,719	0,610	1,836	0,726
Item 5	0,18	0,448	0,602	1,130	0,736
Item 6	0,12	0,410	0,503	0,864	0,741
Item 7	0,30	0,592	0,593	1,471	0,731
Item 8	0,37	0,638	0,694	1,855	0,723
Item 9	0,10	0,549	0,414	0,951	0,742
Item 10	0,11	0,593	0,369	0,918	0,744
TOTAL	4,45	4,188	1,000	17,542	0,800

Reliability of AUDIT and weekly alcohol consumption diary.

Comparing AUDIT to the gold standard of the weekly consumption diary, consistent results were obtained in 90% of cases. The Spearman correlation coefficient was 0.87, pointing to a good level of reliability, and on the basis of the Altman criteria the Kappa value of 0.85 is very good (Table 4).

Reliability of AUDIT-C and weekly alcohol consumption diary.

Comparing the short version, AUDIT-C, to the weekly diary measuring consumption in SDUs, reliability was also moderate to good. Spearman's correlation coefficient was 0.57, indicative of a good level of concordance. The Kappa value of 0.5 is moderate according to the Altman criteria (Table 5).

Content validity

For this analysis, students with *moderate-* and *high-risk consumption* were selected. The average AUDIT score in the *moderate-risk consumption* group was 9.45 among men, and 7.92 for women, while the average AUDIT scores for those with *high-risk consumption* were 15.19 and 13.09 for men and women respectively. Statistically significant ($p < .001$) differences were found in AUDIT for the different types of consumption; thus the test is shown to be valid for discriminating between groups of individuals with different consumption patterns.

Analyzing the item scores in the different risk groups, we can see that they increase gradually from low- through moderate- to high-risk groups depending on the types of consumption pattern, except in item 2. This item states: *How*

many drinks do you have on a day with normal alcohol consumption? with possible responses being: 0 (one or two), 1 (three or four), 2 (five or six), 3 (from seven to nine), or 4 (ten or more). For this question, the average score in the moderate-risk group is higher than in the high-risk group (1.81 vs. 1.64). The response "five or six drinks" in the *moderate-risk consumption* group represents an average of 24.15 SDUs per week, and 38.74 SDUs per week in the *high-risk consumption* group, which would mean that given an equal number of drinks (five or six), the intake of alcohol (SDUs) is higher in one group than in the other.

Internal structure validity

On analyzing whether the three original dimensions of AUDIT are reflected in our population, three factors are obtained: the first factor consists of items 4, 5, 6, and 7 with a reliability of 0.87; the second is made up of items 1, 2, 3, and 8 with a reliability of 0.92; the third factor covers items 9 and 10 with a reliability of 0.83. The average size of residual correlations (RMSR) was 0.02, a value which shows that the model is of acceptable fit, although the association of items found differs from the original.

When looking at two dimensions, we find one consisting of the first eight items, *risk consumption*, and a second one covering the two last items, *hazardous consumption*, which would explain 66% of the accumulated variance with a reliability of 0.82 and 0.92 respectively. The root mean square correlation (RMSR) was 0.03 (Table 6)

The different risk levels of alcohol consumption patterns are reflected in the responses to the AUDIT questions

Table 4. Reliability of AUDIT compared to Weekly Alcohol Consumption Diary.

		Consumption Diary				
		Low-risk consumption ^a	Moderate-risk consumption ^b	High-risk consumption ^c	Total	
AUDIT	Low-risk drinkerd	n (%)	952 (54,1)	6 (2,8)	4 (4,7)	962 (73,5)
	High-risk drinkere	n (%)	55 (5,4)	204 (96,7)	4 (4,7)	263 (20,1)
	Drinker with probable ADSf	n (%)	5 (0,5)	1 (0,5)	78 (90,7)	84 (6,4)
	Total	n (%)	1012 (100)	211 (100)	86 (100)	1309 (100)

^a ≤ 21 SDU men and ≤ 14 SDU women. ^b 22-27 SDU men and 15-16 SDU women. ^c ≥ 28 SDU men and ≥ 17 SDU women. ^d ≤ 7 men and ≤ 5 women. ^e 8-12 men and 6-12 women. ^f ≥ 13 men and women. * Spearman correlation (0.87), Kappa (0.85).

Table 5. Reliability of AUDIT compared to Weekly Alcohol Consumption Diar.

		Consumption Diary			
		Low-risk consumption ^a	Moderate-risk consumption ^b	Total	
AUDIT-C	Low-risk consumptionc	n (%)	705 (69,7)	4 (1,3)	709 (54,2)
	High-risk consumptiond	n (%)	307 (30,3)	293 (98,7)	600 (45,8)
	Total	n (%)	1012 (100)	297 (100)	1309 (100)

^a ≤ 21 men and ≤ 14 women. ^b ≥ 22 men and ≥ 15 women. ^c ≤ 3 men and ≤ 2 women. ^d ≥ 4 men and ≥ 3 women. *Spearman correlation (0.57), Kappa (0.50)

Table 6. *Exploratory factor analysis of AUDIT.*

AUDIT	Two factors		Three factors		
	Factor 1	Factor 2	Factor 1	Factor 2	Factor 3
Item 1		0,957		0,647	
Item 2		0,742		0,615	
Item 3		1,028		1,081	
Item 4		0,560	0,618		
Item 5		0,718	1,012		
Item 6		0,591	0,717		
Item 7		0,554	0,498		
Item 8		0,761		0,584	
Item 9	0,832				0,937
Item 10	0,957				0,693
Estimated reliability	0,825	0,923	0,870	0,925	0,833

(especially 3, 5, and 8, according to MANOVA). The variability which was not explained by group differences was 32% in men (Wilks' F42.8 $p < 0.001$) and 25% in women (F75.6 $p < 0.001$). All AUDIT questions were found to be significant in discriminating between different risk patterns of consumption.

Criterion validity

The diagnoses provided by AUDIT and AUDIT-C were compared to the weekly alcohol intake used as the gold standard. The criterion validity of AUDIT for *low-risk drinker*, *high-risk drinker*, and *drinker with physical-psychological problems and probable ADS* was found to have a high *K* value for both sexes (0.83; 0.83; 0.92 for men and 0.88; 0.88; 0.90 for women); the criterion validity for the three categories of drinker shows strong concordance, with even better results found for women in the sub-group *high-risk drinkers*.

The sensitivity values in AUDIT-C were 98% for men and women, although the *K* values obtained by both sexes were moderate (0.49 and 0.51 respectively) with reference to the Altman criteria.

ROC curves

With regard to AUDIT, the best balance between sensitivity and specificity for detecting *high-risk drinkers* was obtained with a cut-off point of 7.5 for men (sensitivity of 95% and specificity of 93%) and 5.5 for women (sensitivity of 98% and specificity of 95%). For *drinkers with physical-psychological problems and probable ADS*, the best cut-off was 12.5 for both sexes (sensitivity of 95% for men and 86% for women, and specificity of 99% for both).

In the case of *high-risk drinker*, the area under the ROC curve showed very good performance for men (0.963) and excellent performance for women (0.976). For *drinker with physical-psychological problems and probable ADS*, the area under

the curve was excellent in both sexes (0.983 for men and 0.973 for women). In terms of validity, comparing the scores with the weekly consumption diary yielded values close to 1 for the areas under the curve of both categories.

For AUDIT-C, the best balance between sensitivity and specificity for *high-risk consumption* was found at 4.5 for men (sensitivity of 91% and specificity of 84%) and 3.5 for women (sensitivity of 86% and specificity of 88%). The area below the curve according to sex showed the test to be very good (0.941 for men, 0.945 for women). In terms of validity, the results yielded values close to 1 for the categories under investigation when comparing scores to the weekly consumption diary.

Analyses of cut-off points

For the AUDIT categories of *high-risk drinker* and *drinker with physical-psychological problems and probable ADS*, the optimal cut-off points were found to be 8 and 13 for men, and 6 and 13 for women respectively. The best cut-offs for *high-risk consumption* in AUDIT-C were 5 for men and 4 for women (Table 7).

Discussion

The socio-demographic characteristics of the sample are similar to those of other studies into alcohol consumption among university students (Adewuya, 2005; Kokotailo et al., 2004; Londoño, García, Valencia, & Vinaccia, 2005; Martín-Montañez et al., 2011; Montaña, Morales, Gómez, Vera, & Gantiva, 2011; Salazar, Ávila, Pérez, & Martínez, 2010; Seguel, Santander, & Alexandre, 2013; Zaldívar, López, García, & Molina, 2011), with women (59.01%) slightly outnumbering men, and an average age of 21.78. A third of these students live away from the family home, and it is this group that presents more frequent moderate- to high-risk consumption patterns, a greater number of high-risk drinkers, and drinkers with physical-psychological problems and probable ADS. These facts highlight the need take into consideration students' living arrangements when planning preventive measures.

Reliability estimates of AUDIT scores using Cronbach's alpha were good, both globally and for each of the subscales, thereby confirming its suitability for screening for alcohol consumption problems in the university context. The reliability values are quite similar to those found in a systematic review which included 10 studies in different contexts (Meneses-Gaya, Waldo, Regina, & Crippa, 2009), in samples of the general population (Alvarado, Garmendia, Acuña, Santis, & Arteaga, 2009; Contel, Gual, & Colom, 1999; Rubio et al., 1998), and in two samples of American (Kokotailo et al., 2004) and Chilean (Seguel et al., 2013) university students, where average values of 0.8 were obtained.

The fact that the highest scores were found in items 1, 2, and 3 (focusing on the quantity and frequency of alco-

hol consumption) and lower scores in items 5, 6, 9 and 10 (measuring the adverse consequences of drinking such as dependence, injuries or the criticism of others) is indicative of alcohol abuse, and is in line with, on the one hand, the changing pattern of alcohol consumption among young people in which binge drinking (BD) plays an important role, and the lower frequency of alcohol dependence in this sector of the population on the other.

The results of the AUDIT subscale for *hazardous drinking* revealed that the prevalence of students who claimed difficulties in giving up alcohol was 6.4% of the total sample and 9.4% for the drinkers subgroup; this highlights the fact that up to a tenth of the university student drinker population is at risk of ADS. A Chilean study of university drinkers (Baader et al., 2014) reported probable ADS of just 1.5%.

With regard to item 2 in AUDIT, the response option "five or six drinks" reveals that weekly consumption is higher among drinkers with *moderate-risk consumption* than with *high-risk consumption* (24.18 SDUs vs. 38.74 SDUs per week). This item reflects the quantity of drinks, not the frequency of consumption, so when analyzing content validity we have to bear in mind that an individual may consume many low-strength drinks every day, while others may have fewer but stronger drinks. Moreover, on validating AUDIT in Catalan and Spanish (Contel et al., 1999), this item performed differently compared to the validation in Spanish by Rubio et al. (1998); a consequence, it was claimed, of the translation. Given these considerations, it would appear advisable to revise item 2 in such a way as to make it possible to analyze frequency and quantity separately. Given the growth of the

BD phenomenon, a further improvement would be to specify the frequency parameter more exactly, taking into consideration the number of drinks consumed at a single sitting and not on a whole day; and in terms of quantification, it would be interesting to incorporate the concept of SDUs.

With respect to item 3 in AUDIT: *How often do you have six or more alcoholic drinks at a single sitting?* Kokotailo et al., (2004) in their validation for American university students recommended that this should be reduced to five or more drinks for men and four or more drinks for women. If we remember that BD consists of drinking a quantity of alcohol equivalent to or greater than 5 SDUs in a single sitting, it should be pointed out that this can happen independently of the consumption pattern. In our study, on analyzing the criterion validity of those with high consumption with AUDIT, a moderate *K* value is obtained for both sexes (0.54 for men and 0.59 for women), with a positive predictive value of 82.8% for men and 80.2% for women. Given the above, it would be advisable to redraft this item, reducing it to five or more drinks at a single sitting and, better still, incorporating the concept of five SDUs, thereby more accurately reflecting the BD phenomenon.

The original structure of AUDIT features three dimensions: high-risk consumption (items 1-3), dependence symptoms (items 4-6) and hazardous alcohol consumption (items 7-10). The factor analysis of AUDIT, however, can produce different results depending on the prevalence of the problem in the population under consideration. In our case, the three-dimensional factorial model obtained does not exactly match the original structure since items 7 and 8

Table 7. Indexes of validity and utility for the AUDIT and AUDIT-C cut-off points.

	AUDIT				AUDIT-C	
	High-risk drinker C.P.: 8	High-risk drinker C.P.: 6	Drinker with probable ADS C.P.: 13	Drinker with probable ADS C.P.: 13	High-risk consumption C.P.: 5	High-risk consumption C.P.: 4
	Men	Women	Men	Women	Men	Women
S	0,95	0,98	0,95	0,86	0,91	0,86
SP	0,93	0,95	0,99	0,99	0,84	0,88
PPV	0,8	0,85	0,91	0,95	0,63	0,69
NPV	0,98	0,99	0,99	0,99	0,97	0,96
PWC	0,93	0,95	0,99	0,99	0,86	0,88
PBC	0,06	0,04	0,01	0,01	0,14	0,12
LR+	13,54	18,88	117,38	315,23	5,69	7,49
LR-	0,05	0,02	0,05	0,14	0,11	0,15
K	0,83	0,88	0,92	0,90	0,65	0,68
SE	0,93	0,95	0,99	0,99	0,86	0,88
YJ	0,88	0,92	0,94	0,86	0,75	0,75

Note. ADS (Alcohol Dependence Syndrome); C.P. (Cut-off point); S (Sensitivity); Sp (Specificity); PPV (Positive Predictive Value); NPV (Negative Predictive Value); PWC (Percentage Well Classified); PBC (Percentage Badly Classified); LR+ (Positive Likelihood Ratio); LR- (Negative Likelihood Ratio); K (Kappa Coefficient); SE (Standard Efficiency); YJ (Youden's J).

do not remain in the hazardous drinking domain: item 7 is moved to symptoms of probable dependence, and item 8 to high-risk consumption.

We believe that from the point of view of designing intervention programs for the university population, it would be more suitable to adopt a two-factor design where the AUDIT test scores discriminate with great reliability between high-risk and hazardous consumption.

Indeed, in our study university students displayed a prevalence of problematic alcohol consumption of 26.5% (with 20.1% in the *high-risk drinker* category, and 6.4% in *drinker with physical-psychological problems and probable ADS*), and two factors were obtained consisting of items 1-8 and 9-10 respectively.

Other studies of the general population also support a bi-dimensional structure (Contel et al., 1999; Lima et al., 2005; Meneses-Gaya et al., 2009), while in the Chilean university population (Seguel et al., 2013), two components were also established which were linked to consumption itself and to the adverse consequences of excessive consumption.

In terms of internal validity, the sensitivity and specificity results obtained for AUDIT (sensitivity = 32-96%, specificity = 84-96%) are among the highest published (Barry, & Fleming, 1993; Rubio et al., 1998; Saunders, Aasland, Babor, de la Fuente, & Grant, 1993; Schmidt, Barry, & Fleming, 1995), which demonstrates its utility in screening for alcohol related problems in this sector of the population.

Numerous AUDIT validation studies have achieved good sensitivity and specificity when applying different cut-off points (Adewuya, 2005; Dawson, Grant, & Stinson, 2005; Gache et al., 2005; Knight, Sherritt, Harris, Gates, & Chang, 2003; Kokotailo et al., 2004; Rubio et al., 1998), highlighting the need to establish different cut-offs depending on sex. Given that equal consumption is more likely to have repercussions among women than men, it is advisable to reduce the cut-off point for women when planning interventions (Reinert & Allen, 2002, 2007).

In terms of ROC curves, the area under the curve can be seen as an indicator of the quality of a diagnostic test, and for the category *high-risk drinker* in the case of AUDIT this was 0.96 for men and 0.98 for women, while for *drinker with physical-psychological problems and probable ADS*, the areas were 0.98 for men and 0.97 for women. These values can be considered extremely good, and better than those obtained in the Spanish validation of AUDIT carried out in primary health care (Rubio et al., 1998), where an area of 0.87 was obtained for alcohol use, and the Chilean version (Alvarado et al., 2009), with areas of 0.93 for high risk drinking, 0.88 for hazardous drinking and 0.91 for dependence. Turning to values obtained in studies of university students, the results yielded by the AUDIT validation carried out in the University of Wisconsin were worse, with areas of 0.87 for alcohol consumption and 0.77 for abuse or dependence.

In this study, the most effective cut-off points in AUDIT for problematic alcohol use (*high-risk drinker*) among men

was 8 (sensitivity = 95% and specificity = 93%) and 6 for women (sensitivity = 98% and specificity = 95%). In the Spanish validation of the instrument (Rubio et al., 1998), the general cut-off point for detecting problems with alcohol use was 8, but when analyzing sensitivity and specificity by sex, differences were encountered and the cut-off point for men was 9 and higher, with 6 or higher among women. The validation for Catalan and Spanish (Contel et al., 1999) also established a cut-off point of 9 for men but did not detect a different point for women. In an AUDIT validation study carried out exclusively with women in two primary care centers and in a drug dependence center (Pérula et al., 2005), a cut-off point of 6 or higher was obtained.

Taking the results obtained into account, we recommend that the cut-off point for male university students be reduced by one point below the values found in two validation studies in the general population in primary care. This recommendation is supported by a systematic review of AUDIT (Meneses-Gaya et al., 2009), which affirms that its sensitivity and specificity are lower when applying the standard cut-off points to the university population.

Regarding the detection of *drinkers with physical-psychological problems and probable alcohol dependence (ADS)*, the most efficient cut-off point in our study was 13 or higher for both sexes, identical to that recommended in primary care for the general population (Rosón, 2008).

With reference to the criterion validity of AUDIT-C, it may appear contradictory that a test which detects 98% of cases is not useful in detecting high-risk consumption, but it must be pointed out that the low prevalence of consumption among university students generates as many false negatives as true positives, which means that there is only an even probability of detecting positive cases, as reflected in the kappa value.

Despite the reliability estimate for AUDIT-C in this population not being particularly good (Kappa index 0.50), this could be improved for the detection of *high-risk consumption* if cut-off points are raised by one point above those recommended for men (Bush et al., 1998) and women (Bradley et al., 2003). Raising the cut-off points in this way to 5 and 4 respectively significantly increases their predictive power.

The need to detect BD among young people is stressed in the latest report (2011) by the Spanish Observatory on Drugs and Drug Addiction, which describes a high prevalence of this intermittent consumption pattern. Moreover, according to the data provided in EDADES 2011/12, the figures for binge drinking in the last 30 days have risen slightly; 15.2% of those surveyed have consumed alcohol in this way, and this high-risk pattern of consumption is particularly extended among young adults, aged 20-29, of both sexes. The criterion validity or diagnostic validity of detecting binge drinkers with AUDIT is low, with moderate Kappa values obtained for both sexes. AUDIT-C, however, displays good

sensitivity for detecting problems with alcohol use and binge drinking in both men and women (AUDIT: sensitivity of 0.58 for men and 0.64 for women vs. AUDIT-C: sensitivity of 0.81 for men and 0.85 for women)

A possible limitation of this study is the lack of a test-retest analysis, but this was not carried out on organizational grounds and to avoid doubts on the part of the students regarding loss of confidentiality.

In conclusion, its psychometric properties make AUDIT a suitable instrument for the timely detection of problems with alcohol use in the university population, although lowering the cut-off point to 8 for men and revising items 2 and 3 is recommended in order to improve its predictive power in detecting binge drinking. The predictive strength of AUDIT-C would be improved by raising the cut-off points by one for both sexes.

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Conflict of interests

The authors declare no conflict of interests.

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