

## The utility of the Alcohol Use Disorders Identification Test (AUDIT) for the analysis of binge drinking in university students

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### Abstract

**Background:** The increasingly precise conceptualization of Binge Drinking (BD), along with the rising incidence of this pattern of intake amongst young people, make it necessary to review the usefulness of instruments used to detect it. Little evidence exists regarding effectiveness of the AUDIT, AUDIT-C and AUDIT-3 in the detection of BD. This study evaluates their utility in a sample of university students, revealing the most appropriate cut-off points for each sex. **Methods:** All students self-administered the AUDIT and completed a self-report of their alcohol consumption. A Two-step cluster analysis differentiated 5 groups of BD in terms of: the quantity consumed, the frequency of BD over the past six months and gender. A ROC curve adjusted cut-off points for each case. **Results:** 862 university students (18-19 years-old/59.5% female), 424 (49.2%) from Valencia and 438 (50.8%) from Madrid, had cut-off points of 4 in AUDIT and 3 in AUDIT-C as a better fit. In all cases, the best classifier was AUDIT-C. Neither version properly classifies students with varying degrees of BD. **Conclusions:** All versions differentiate BD from non-BD, but none are able to differentiate between types of BD.

**Keywords:** AUDIT, AUDIT-C, AUDIT-3, university students, Binge Drinking.

### Resumen

**Utilidad del Alcohol Use Disorders Identification Test (AUDIT) en el análisis del binge drinking en estudiantes universitarios. Antecedentes:** la operacionalización cada vez más precisa del Binge Drinking (BD), unido a su elevada prevalencia entre los jóvenes, hace necesario revisar la utilidad de los instrumentos utilizados para detectarlo. Existe poca evidencia de la eficacia del AU-DIT y AUDIT-C en la detección del BD. Este artículo evalúa su utilidad en una muestra de universitarios, identificando los puntos de corte más adecuados, en función del sexo. **Método:** se cumplimentó el AUDIT y un autoregistro de consumo de alcohol. Un análisis de conglomerados en dos fases diferenció 5 grupos de BD en función de: cantidad consumida, frecuencia de realización en los últimos seis meses y género. Con curvas ROC se ajustaron los puntos de corte para cada caso. **Resultados:** 862 universitarios (18-19 años/59,5% mujeres), 424 (49,2%) de Valencia y 438 (50,8%) de Madrid obtuvieron puntos de corte de 4 en AUDIT y 3 en AUDIT-C como mejor ajuste. En todos los casos el mejor clasificador de BD fue el AUDIT-C. Ninguna versión clasifica adecuadamente a estudiantes con diferente intensidad de BD. **Conclusiones:** ambas versiones diferencian BD de noBD, pero ninguna de ellas permite distinguir entre tipos de BD.

**Palabras clave:** AUDIT, AUDIT-C, AUDIT-3, universitarios, Binge Drinking.

Binge drinking (BD) is one of the major high-risk behaviours of university students (Wicki, Kuntsche, & Gmel, 2010). Recent research on young binge drinkers reveals a multitude of related consequences, including physiological changes in parameters such as blood pressure and state anxiety immediately following consumption and cognitive impairment in memory, attention and execution (López et al., 2014). In college students this pattern has been associated with other health risks and psychosocial problems, including traffic incidents, personal injuries, legal problems, sexually transmitted diseases, and negative academic performance (Davoren, Shiely, Byrne, & Perry, 2015; Kypri, McGee, Saunders, Langley, & Dean, 2002).

Epidemiological studies have reported that this consumption pattern exists in many countries (Eurobarometer, 2010; CNAPA, 2014; SAMHSA, 2014). The prevalence of BD in young people varies significantly (7%-40%) (Hibell et al., 2004; Newes-Adeyi, Chen, Williams, & Fader, 2005). The youngest of the assessed groups, between 15-24 years of age, was found to engage in BD to the greatest extent, with 25% engaging in this type of consumption at least once a week (Eurobarometer, 2010).

Studies conducted across Europe have revealed a prevalence of approximately 40% in university students (Caamaño-Isorna, Corral, Parada, & Cadaveira, 2008), confirming the increased presence of this consumption pattern until the age of 22 (D'Alessio, Baiocco, & Laghi, 2006).

Differences between males and females are increasingly fewer, although males continue to be more likely to report this type of consumption (Cortés, Giménez, Motos, & Cadaveira, 2014; Eurobarometer, 2010; OED, 2013).

International controversy has surrounded the definition of BD (Cortés & Motos, 2015). In its operationalization, three aspects tend to be used, implemented either independently or in combination: the amount of alcohol ingested, the time period of consumption and the time frame of BD. It is typically recommended that the definition from the National Institute on Alcohol Abuse and Alcoholism (NIAAA, 2004) be used, adjusting the grams of alcohol for each drink to the Spanish standard and adding the time frame of BD. According to Cortés, Giménez, Motos and Sancerni (2016), one possible operational definition of BD for the Spanish population would be the consumption of  $\geq 7$  standard Spanish drinks (1 SDU= 10g) in a row for men, or  $\geq 6$  in a row for women, bringing the BAC to .08g/l, at least once over the past 6 months. Nevertheless, this criterion indicates only the minimum threshold necessary to consider consumption as BD, including a diverse range of drinkers.

The presence of this consumption pattern amongst university students and the related problems justifies the importance of having instruments that permit early detection and that suggest preventive measures. The *Alcohol Use Disorders Identification Test* (AUDIT) is one of the most extensively used screening tests worldwide (Cortés et al., 2016; de Meneses-Gaya, Zuairi, Loureiro, & Crippa, 2009). Recent research has found this tool to be currently valid for identifying hazardous alcohol consumption in young adults (Aalto, Alho, Halme, & Seppä, 2009; Dawson, Grant, Stinson, & Zhou, 2005) and college students (Adewuya, 2005; Kokotailo, Egan, Gangnon, Brown, Mundt, & Fleming, 2004). However, it is unknown whether this instrument is suitable for the detection of BD, as reported by minors who engage in this behaviour (Cortés et al., 2016). Therefore, there was an interest in discovering the sensitivity, specificity and predictive power of AUDIT and its abbreviated versions, for the university population, and in determining the utility and validity of these tests.

In the Spanish validation of the instrument (Rubio, Bermejo, Caballero, & Santo-Domingo, 1998), the general cut-off point for detecting problems with alcohol use was 8, but when analysing sensitivity and specificity by gender, differences were encountered and the cut-off point for men was established at 9 (6 for women). In a systematic review of AUDIT (de Meneses-Gaya et al., 2009), it was recommended that the cut-off points for university students should be lower (5-6) than the standard cut-off points.

Studies that have used AUDIT for screening BD in university students (Adewuya, 2005; Kokotailo et al., 2004) have used different cut-off scores, ranging from 5 to 8, with a sensitivity and specificity between 80-93% and 78-92%, respectively. This variability is due to the use of different BD at-risk criterion measurements and due to the distinct nationalities of the samples.

Several studies with university-aged populations (DeMartini & Carey, 2012; Lee, Kim, Jung, Choi, & Ryou, 2011) and other samples (Aalto et al., 2009; Patton & Boniface, 2016) indicate that the optimal cut-off point for females should fall between one and three scores lower than those for males.

On the other hand, DeMartini and Carey (2012), looking at BD in first-year students, report that the AUDIT-C performs significantly better than the AUDIT, having cut-off scores of 7 for men and 5 for women. These cut points are higher than those reported in earlier studies with different samples (Aalto et al., 2009; Haug, Ulbricht, Hanke, Meyer, & John, 2011).

Recently, García, Novalbos, Martínez and O'Ferrall (2016) concluded that the AUDIT-C displays good sensitivity for

detecting problems with alcohol use and BD in both men and women (AUDIT: sensitivity of .58 for men and .64 for women vs. AUDIT-C: sensitivity of .81 for men and .85 for women). These results contradict those of McCambridge and Thomas (2009), who considered young people between the ages of 16-24 who were consumers of any quantity of alcohol, concluding that the AUDIT had a greater predictive power than its abbreviated versions.

The few studies that have included the AUDIT-3 report similar results to those found with the other AUDIT forms, but only in males with a cut-off point of  $\geq 2$  (Aalto et al., 2009; Tuunanen, Aalto, & Seppä, 2007). This is one point higher than the score reported by Matano, Koopman, Wanat, Whitsell, Borggreve and Westrup (2003), who used BD threshold as the gold standard.

As has been done previously with underage BD (Cortés et al., 2016), the focus is (1) to determine the existence of different types of binge drinkers, depending on the intensity and frequency of use by each gender and (2) to determine the optimal cut-off scores on the AUDIT, AUDIT-C and AUDIT-3, in order to best identify the college students engaging in BD and to find differing performance of these instruments in BD groups. This will allow for improvement of the clinical utility of these instruments, potentially adjusting the interventions to be carried out.

## Method

### Participants

The sample size was 862 university students (59.5% female), 424 from Valencia (49.2%) and 438 from Madrid (50.8%). Of these, 552 (64%) were 18 years old and 310 (36%) were 19 years old. 67.7% (n= 584) complied with the proposed BD operationalization criteria (39.6% male).

### Instruments

A self-report diary was used, in which for each day of the week, participants were to indicate the type and number of drinks consumed and the approximate time when drinking took place. The Spanish SDU –10g– was used to convert the amounts of consumption to alcohol grams. The recoding of all consumption occasions allowed for the identification of the *greatest number of grams of alcohol consumed in a session*. According to this variable, students were classified as BD ( $\geq 70$ g males/ $\geq 60$ g females), or non-BD.

The frequency of BD was operationalised by asking the *number of total BD days within 6 months* that they had consumed alcohol at this level.

Participants also completed the AUDIT. Three different scores were obtained: AUDIT (10 items), AUDIT-C (the first three items) and AUDIT-3 (question number three). The internal consistency of the AUDIT and the AUDIT-C was .74 and .82, respectively.

### Procedure

A cross-sectional study was conducted on first year students at the University of Valencia and the Complutense University of Madrid. For each area of knowledge, the faculties with the largest number of enrolled first-year students were selected. In each degree area, one group of students was assessed in the morning and another in the afternoon.

Questionnaires were administered in classrooms during academic hours throughout 2012. Participation was voluntary and anonymous. The study was conducted in compliance with Spanish legislation (approved by the Department of Education) and the code of ethics for research involving human subjects, as outlined by the University of Valencia Human Research Ethics Committee.

23 questionnaires were eliminated due to missing information, or because the participant exceeded the established age range.

Potential inconsistencies were corrected for the first three items of the AUDIT and the consumption self-register, with priority given to the latter.

*Data analysis*

In order to establish homogenous groups from the intense consumers, based on the parameters *greatest number of grams consumed in a session* and *number of total BD days within the past six months*, a pair of Two-Step cluster analyses were conducted, one for females and another for males.

To determine whether differences existed in these parameters, an analysis of variance (ANOVA) was performed, with its corresponding *a posteriori* tests -Tukey-, using the groups obtained in the clusters as independent variables.

Three ROC (*Receiver Operating Characteristic*) analyses were carried out in order to determine the point at which the false negatives were minimised. ROC curves were calculated using the method proposed by Hanley and McNeil (1983). One of these was conducted with all of the alcohol users, classifying them according to whether they engaged in BD or not. The other two only included young BD, one with females and another with males. In both cases, the groups obtained in the cluster analysis were used.

Our goal in determining the optimal cut-off score for the AUDIT was to minimise false negatives and to thereby improve the detection of college students who engage in BD. Therefore, cut-off scores were used in order to maximise sensitivity.

In the absence of a gold standard, Zweig and Campbell (1993) suggest using a consensus or majority expert opinion. As described in the introduction, the gold standard used in this study was consumption of  $\geq 70$  grams for men and  $\geq 60$  grams for women in a BD session.

All statistical procedures were performed using the SPSS 22.0 and considering  $p < .05$  as significant.

**Results**

Regarding the first objective, the cluster analysis for BD females produced three differentiated groups (BD1F/BD2F/BD3F) (Table 1). One quarter of the women (BD3F) exceeded the cut-off point used to classify by more than double the total amount. The cluster analysis for BD males produced two groups (BD1M/BD2M). In this case, one third of the men (BD2M) consumed almost three times the amount of alcohol grams that would classify them as BD.

Significant differences existed between the 5 groups (BD1F/BD2F/BD3F/BD1M/BD2M) in terms of the number of grams consumed ( $F_{(4,204221.489)} = 173.132; p < .0001$ ) and the number of total BD days within 6 months ( $F_{(4,16636.913)} = 200.814; p < .0001$ ).

For the women, two groups (BD1F/BD2F), representing a large majority (76.2%), consumed the same quantity of alcohol ( $p=1$ ),

although one of these groups (BD2F) did so on a much more regular basis ( $p < .001$ ).

The male groups (BD1M/BD2M) revealed significant differences in intensity ( $p < .001$ ) and frequency of consumption ( $p < .001$ ), and it was found that the greater the quantity of grams consumed, the greater the regularity of behaviour.

Comparing the two BD females groups and the less intense male group (BD1F+BD2F/BD1M), the males were seen to consume a greater amount of alcohol ( $p < .001$ ), although not always on a greater number of occasions ( $p = .9$ ). In the groups with an intense consumption level (BD3F/BD2M), it was men who prevailed on both indicators ( $p < .001$ ).

The three versions of the AUDIT revealed good values for the area under the ROC curve in terms of detecting BD for the entire sample (Table 2).

A score of 4 on the AUDIT detected 97.3% of the BD (sensitivity) and 84.2% of the non-BD (specificity). In the AUDIT-C, a score of 3 improved the sensitivity and specificity, categorising both those who do and do not engage in BD more precisely. Question 3 is equally sensitive as the AUDIT in detecting BD, but was much better at identifying the non-BD individuals.

*Table 1*  
Binge Drinking groups differentiated by sex resulting from the cluster analysis

	Cluster	N (%)	Grams (SD)	Days within 6 months (SD)
FEMALE	BD1F	147 (41.6)	84.4 (19.5)	16.0 (5.6)
	BD2F	122 (34.6)	84.2 (14.5)	32.5 (5.5)
	BD3F	84 (23.8)	147.8 (33.1)	37.4 (12.3)
MALE	BD1M	157 (68.0)	113.6 (32.9)	25.4 (10.6)
	BD2M	74 (32.0)	195.0 (68.3)	49.9 (11.1)

*Note: BD1F=Group one of binge drinkers (BDs), females; BD2F= Group two of BDs females; BD3F= Group three of BDs females; BD1M= Group one of BDs males; BD2M= Group two of BDs males*

*Table 2*  
Performance of the three versions of the AUDIT in detecting Binge Drinking for the entire sample

	Cut-off	Sensitivity	Specificity	ROC (95% Confidence Interval)
AUDIT	$\geq 3$	.993	.752	.964 (.949-.978)
	$\geq 4$	.973	.842	
	$\geq 5$	.930	.914	
	$\geq 6$	.807	.946	
	$\geq 7$	.685	.960	
	$\geq 8$	.572	.968	
	$\geq 9$	.464	.978	
AUDIT-C	$\geq 3$	.983	.953	.994 (.989-.998)
	$\geq 4$	.926	.989	
	$\geq 5$	.759	.996	
	$\geq 6$	.527	.996	
	$\geq 7$	.375	1.000	
	$\geq 8$	.228	1.000	
AUDIT-3	$\geq 1$	.979	1.000	1.000
	$\geq 2$	.690	1.000	(1.000-1.000)

*Note: ROC= Receiver Operating Characteristic*

For women (Table 3, Figure 1), the three versions of the questionnaire were effective in classifying those who engage in BD and those who do not. Specifically, the AUDIT-3 and the AUDIT-C correctly classified the greatest number of BD (sensitivity) and non-BD (specificity).

Similar results were obtained for men (Table 4, Figure 1). The three tests differentiate well between BD/non-BD (95% confidence interval AUDIT: .931-.978/AUDIT-C: .983-.999/AUDIT-3: 1.000-1.000). AUDIT-3 and the AUDIT-C achieved a better balance between sensitivity and specificity.

The data suggests that 4 is an accurate cut-off point for the AUDIT and 3 for the AUDIT-C, regardless of gender. Furthermore, the AUDIT-C is found to have better classifications. The balance between the two indicators decreases notably in the poorly-classified non-BD; finally, for women, sensitivity was improved (98.6%).

When comparing the BD groups by differentiating between those who drink less alcohol, less frequently (BD1M / BD1F+BD2F) and those who drink more alcohol, more frequently (BD2M/BD3F), all versions of the questionnaire were found to be quite sensitive, with the AUDIT-C being slightly better. The area under the curve for females was .874 (95% confidence interval=.832-.917) and for males was .900 (95% confidence interval=.860-.939). None of these appropriately detected those with a more moderate consumption.

### Discussion

Generally speaking, when taking gender differences into account, the three versions of the AUDIT may be considered appropriate screening instruments to classify BD and non-BD. Specifically, in the case of the AUDIT, the cut-off point with the greatest sensitivity and specificity is 4. This level is lower to that obtained in other studies (Adewuya, 2005; de Meneses-Gaya et al., 2009; Kokotailo et al., 2004), but with it, a greater number of correct classifications were attained, perhaps justified by the increased rigour with which BD was operationalised in this work.

Two aspects should be noted in regards to the cut-off point of 4. On the one hand, the coincidence with that obtained in samples with minors having a similar consumption behaviour (Chung, Colby, Barnett, Rohsenow, Spirito, & Monti, 2000; Cortés et al., 2016). On the other hand, the lack of difference between men and women for the cut-off point in the AUDIT, contradicting studies such as those by Lee et al. (2011) and DeMartini and Carey (2012). This similarity may be due to the elevated consumption found in BD females, which is higher than the minimum level established for men.

In the case of the AUDIT-C, we have coincided with other studies which, using different samples of distinct ages, suggested lower cut-off points than those obtained by DeMartini and Carey (2012). In fact, our study reveals higher sensitivity and specificity than earlier studies that use higher scores (DeMartini & Carey, 2012; García et al., 2016; Haug et al., 2011).

When comparing the area revealed by the ROC curve in the AUDIT and in the AUDIT-C, a greater predictive value was found for the AUDIT-C, regardless of gender. The trend suggested by García et al. (2016) was confirmed, supporting the preferential use of the AUDIT-C for the screening of this population.

It is logical that item 3, in the face of elevated consumption by both men and women, revealed such high levels of sensitivity and specificity, decreasing its cut-off point in all cases to  $\geq 1$ .

When considering only binge drinkers, the fit of the three versions of the AUDIT was less precise in terms of identifying differences among them, especially for those who practised the least extreme BD. The AUDIT and its reduced versions are appropriate tools for the screening of college students who engage in this behaviour, but they are unable to determine differences between different types of binge drinkers. Those BD students consuming the least alcohol and those consuming it for the lowest number of days were the most difficult to identify. These same results were obtained for adolescent BDs (Cortés et al., 2016).

It is important to highlight the homogeneity of the results obtained, both in cut-off points for the distinct tests, as well

Table 3  
Performance of the three versions of the AUDIT in detecting BD females

Version	Cut-off	BD/nonBD (N= 484)			BD3F/BD1F+BD2F (N= 411)		
		Sensitivity	Specificity	ROC (95% Confidence Interval)	Sensitivity	Specificity	ROC (95% Confidence Interval)
AUDIT	$\geq 3$	.994	.794	.976 (.960-.991)	1.000	.007	.820 (.774-.867)
	$\geq 4$	.966	.863		1.000	.045	
	$\geq 5$	.921	.950		1.000	.104	
	$\geq 6$	.785	.975		1.000	.283	
	$\geq 7$	.632	.981		.940	.465	
	$\geq 8$	.501	.988		.857	.610	
	$\geq 9$	.391	.994		.786	.732	
AUDIT-C	$\geq 3$	.986	.963	.996 (.993-1.000)	1.000	.019	.874 (.832-.917)
	$\geq 4$	.907	.994		1.000	.123	
	$\geq 5$	.717	1.000		.988	.368	
	$\geq 6$	.414	1.000		.845	.721	
	$\geq 7$	.249	1.000		.655	.877	
AUDIT-3	$\geq 1$	.983	1.000	1.000	.022	.759 (.702-.815)	
	$\geq 2$	.649	1.000	(1.000-1.000)	.929		

Note: BD=Binge Drinking; nonBD=No Binge Drinking; BD1F=Group one of BDs females; BD2F=Group two of BDs females; BD3F=Group three of BDs females; ROC= Receiver Operating Characteristic

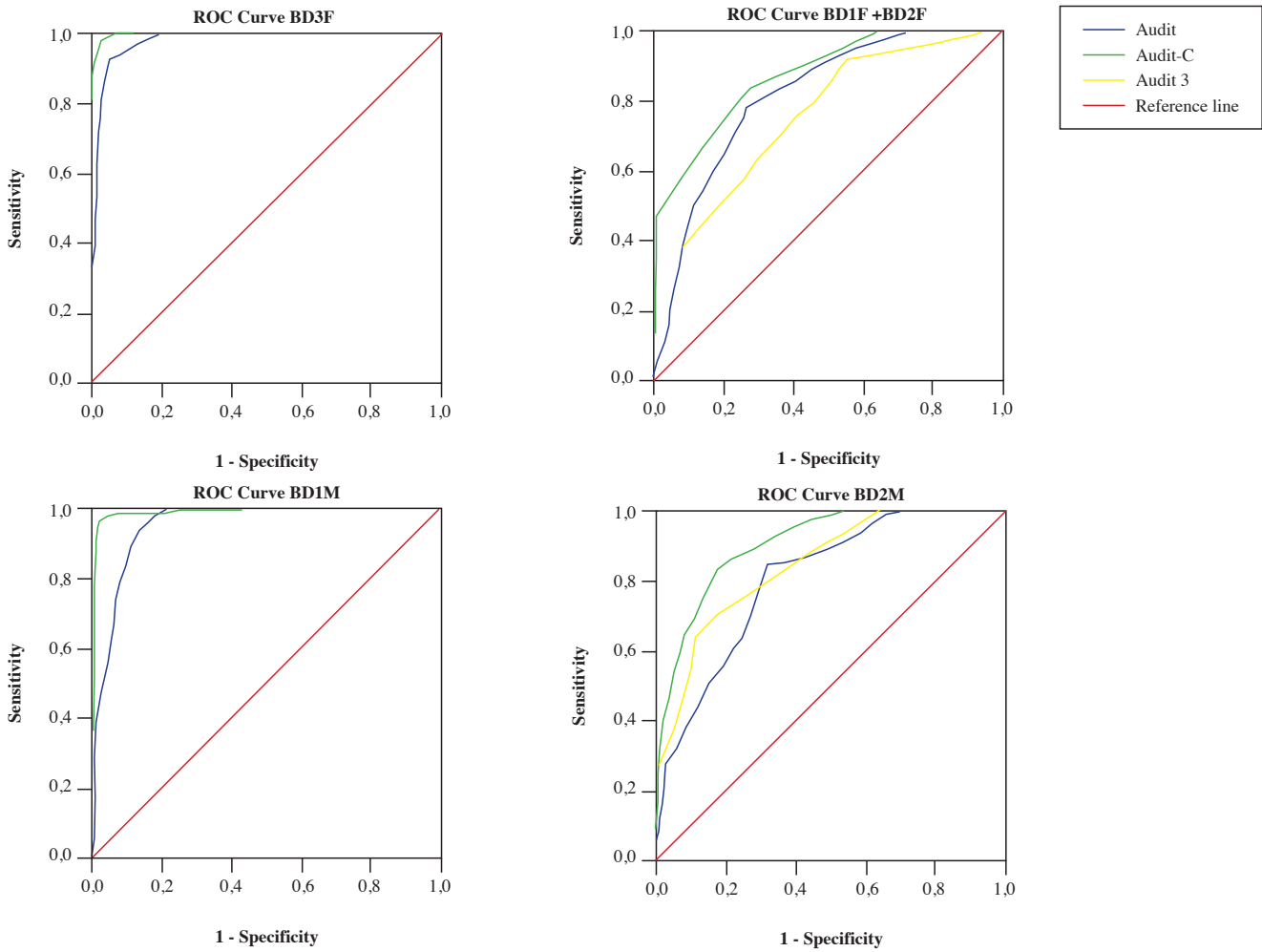


Figure 1. Receiver Operating Characteristic curves comparing AUDIT, AUDIT-C and AUDIT-3 to detect females BD (BD3F–BD1F+BD2F) and males BD (BD1M-BD2M)

Version	Cut-off	BD/nonBD (N= 462)			BD2M/BD1M (N= 344)		
		Sensitivity	Specificity	ROC (95% Confidence Interval)	Sensitivity	Specificity	ROC (95% Confidence Interval)
AUDIT	≥3	.991	.695	.955 (.931-.978)	1.000	.013	.801 (.744-.858)
	≥4	.983	.814				
	≥5	.944	.864				
	≥6	.840	.907				
	≥7	.766	.932				
	≥8	.680	.941				
AUDIT-C	≥3	.978	.941	.991 (.983-.999)	1.000	.032	.900 (.860-.939)
	≥4	.957	.983				
	≥5	.823	.992				
	≥6	.701	.992				
	≥7	.567	1.000				
	≥8	.381	1.000				
AUDIT-3	≥1	.974	1.000	1.000 (1.000-1.000)	1.000	.038	.832 (.779-.885)

Note: BD=Binge Drinking; nonBD=No Binge Drinking; BD1M=Group one of BDs males; BD2M=Group two of BDs males; ROC= Receiver Operating Characteristic



as in errors found in classifying moderate BD amongst heavy consumers, regardless of their age.

Widespread BD amongst individuals under the age of 22 justifies the need to find a screening tool/instrument that permits improved identification between different BD. So, based on our results and those of prior works (Cortés et al., 2016; Kokotailo et al., 2004; Matano et al., 2003; McCambridge & Thomas, 2009), it may be interesting to review the consumption items from the AUDIT. An objective way of doing so would be to consider the operational definition of BD that has been defended in this study. Of the improvements to be considered, we highlight the following: introducing SDU or grams instead of number of drinks; differentiating between the quantity of consumption based on gender; differentiating the quantity of consumption frequency in separate items; adjusting the consumption interval to hours or limiting the recording of this pattern to the past six months.

It may also be useful to examine the consequences included in the AUDIT in terms of the last four items, so as to adapt them to the results of the study that have demonstrated bio-psychological-social differences in youth as compared to adults, given that in the

latter, other harmful alcohol consumption behaviours also tend to appear alongside BD (Martínez, Sher, & Wood, 2014).

Our study has certain limitations, given that it relies on self-reporting (Midanik, 1988). However, self-reports have been shown to be reliable and valid, assuming that they are treated confidentially and when assessment situations are structured, so as to minimise bias (Del Boca & Darkes, 2003).

Another potential limitation lies in the generalisation of the results obtained from this study, considering that this consumption is found to be largely present until the age of 22 (D'Alessio et al., 2006). It is necessary to expand upon the assessment of the AUDIT including the proposed revisions, adding young people of all ages to the overall period of greatest prevalence for this consumption pattern.

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