Alcohol and Alcoholism Advance Access published April 15, 2011

Alcohol and Alcoholism Vol. 0, No. 0, pp. 1–8, 2011 doi: 10.1093/alcalc/agr032

ORIGINAL ARTICLE

The Relationship between Alcohol Consumption and Perceived Drunkenness: a Multilevel Cross-National Comparison in Samples of Adolescents

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(*Received* 5 *November* 2010; *in revised form* 7 *March* 2011; *accepted* 10 *March* 2011)

Abstract — Aims: Alcohol consumption seems to be the best predictor of drunkenness and evidence suggests that individual and country factors influence the perception of drunkenness. This study examines if the relationship between volume of alcohol consumption and perceived drunkenness varies across European countries in samples of adolescents. **Methods:** Data came from the 2007 European School Survey Project on Alcohol and other Drugs (ESPAD). The analytical sample consisted of $n = 60{,}114$ (93%) 15–16-year-old students in 24 countries reporting alcohol consumption on the last drinking occasion. At the individual level, perceived drunkenness on the last drinking occasion was measured with a 10-point scale, alcohol consumption on the last drinking occasion with a beverage-specific quantity index. Six individual characteristics were assessed and used as control variables. At the country level, a total of five country-level variables were included in the study. Data were analysed using multilevel regression models simultaneously considering both individual level (Level 1) and group (country) level (Level 2) variables. **Results:** The relationship between alcohol consumption and perceived drunkenness varied across countries. This variation could partly be explained by drinking patterns and geographical region. **Conclusion:** The perception of the effects of alcohol in terms of drunkenness seems to vary across countries. Future studies should develop sound indicators of cultural differences accounting for this variation.

INTRODUCTION

Drunkenness is a common phenomenon among adolescents. Recent cross-national epidemiological studies have shown that ~50% of adolescents aged 15 in Europe report at least one episode of drunkenness in their life (Hibell *et al*., 2009). About one-third of 15-year-olds in Europe and North America reported two or more episodes of drunkenness (Currie *et al*., 2008). Drunkenness can easily occur in young adolescents with the intake of a relatively small amount of alcohol, which is a cause for concern given that drunkenness implies a loss of motor control and judgement ability, and reduced inhibition (Windle *et al*., 1996; Midanik, 1999). From a public health perspective, excessive alcohol consumption is a major risk factor for morbidity and mortality among this population. Of particular importance are acute health and social problems such as injuries or violence (Rehm *et al*., 2001; Watt *et al*., 2004; Wells *et al*., 2004). Moreover, the three most frequent forms of mortality among adolescents (accidental death, homicide, suicide) are associated with alcohol use (Sells and Blum, 1996; World Health Organization, 2000; Zador *et al*., 2000).

In contrast to alcohol consumption that can be measured objectively (for example, in grams of ethanol or as drinking five or more drinks in a row), drunkenness is a subjective indicator of excessive drinking. It depends on a person's evaluation of the cognitive, behavioural and emotional changes due to alcohol consumption. Adjusting for individual differences in the effects of alcohol, perceived drunkenness has occasionally proven to be a better predictor of acute alcohol-related problems than objective indicators both among adult (Greenfield, 1998; Midanik, 1999) and adolescent populations (Andersson and Hibell, 2007).

Biological studies show that the main determinant of drunkenness is the amount of alcohol intake (Eckardt *et al*., 1998). Yet, genetic factors, gender and body weight play an important role in the metabolism of ethanol and may lead to different perceptions of drunkenness at the same level of alcohol consumption. Interestingly, cross-national studies examining the relationship between prevalence or frequency of alcohol consumption and prevalence or frequency of self-reported drunkenness point to the influence of cultural factors on this relationship. In a descriptive analysis of data from the European School Survey Project on Alcohol and other Drugs (ESPAD) on prevalence of self-reported drunkenness and binge drinking among European adolescents, Andersson and Hibell (2007) found a positive correlation between these variables. However, in some countries very low prevalence rates of self-reported drunkenness were associated with high rates of binge drinking. Similarly, in an analysis of data from the Health Behaviour in School-aged Children (HBSC) study, Schmid *et al*. (2003) found that the association between frequency of alcohol intake and frequency of self-reported drunkenness in Europe was influenced by country characteristics, for instance, geographic location or the presence of mass media campaigns. Thus, factors at the individual as well as at the country level seem to influence the association between alcohol consumption and prevalence or frequency of self-reported drunkenness.

The aim of this study is to investigate if cultural factors influence the relationship between alcohol consumption and perceived drunkenness, i.e. the perceived effects of alcohol in terms of drunkenness. The two aforementioned epidemiological studies provide evidence on the role of cultural factors in the association between alcohol consumption and prevalence or frequency of drunkenness, but do not address the direct link between drinking volume and perceived drunkenness. Providing data on the amount of alcohol consumption at the last drinking occasion and a subjective measure of the extent of the felt effects related to that drinking occasion, this study investigates if the relationship between alcohol consumption and perceived drunkenness varies across

countries. If variation is found, factors at the country level accounting for this variation will be investigated.

METHODS

Total sample

Data came from the 2007 ESPAD study (Hibell *et al.*, 2009). In each of the 35 participating countries, a cluster sampling design was used to sample the target population of students born in 1991. In most of the countries, class was the last unit in a multistage stratified sampling process (Hibell *et al.*, 2009). Class samples are nationally representative, with the exceptions of Germany (only 7 out of 16 federal states) and Belgium (only the Dutch-speaking part).

Data were collected by means of a self-administered questionnaire, mainly during spring 2007. Students answered the questionnaires anonymously in a classroom setting. In all countries, students were informed that participation in the survey was voluntary. In nine countries approval from an ethics committee was obtained, in eight countries permission from a ministry was taken and some form of parental consent was used in 12 countries.

Average class response rate was 90% and student response rate was 87% on average. After data cleaning, 2% of all received questionnaires were discarded from the 2007 ESPAD database due to missing information on age or gender, low completion rate or because of too many repetitive extreme responses. This resulted in a sample size of $n = 104{,}828$ cases. Reliability is considered satisfactory on the whole and validity is considered high in most countries (Hibell *et al.*, 2009).

Analytical sample

Countries with no information on the consumption of beer, wine and spirits on the last drinking occasion (the Faroe Islands, Ireland, Latvia and Portugal), missing data on drunkenness on the last drinking occasion (Denmark), no information on one of the covariates (for Iceland no information on parental control was available) or on one of the country-level predictors (for Cyprus, the Isle of Man, Malta and Monaco no information on the patterns of drinking score was available) were excluded ($n = 23{,}717$). Armenia was discarded due to its detached regional position ($n = 4055$). The 24 countries included are shown in Tables 1 and 2. In addition, the corrected sample was restricted to subjects with lifetime alcohol consumption ($n = 12{,}136$) resulting in $n = 64{,}740$ students (61.8% of the original study population). After exclusion of cases with implausible answers for beer, wine and spirits consumption on the last drinking occasion ($n = 2655$, 4.1%), students with missing values on drunkenness and inconsistent responses on alcohol consumption and drunkenness ($n = 1725$, 2.7%) and subjects with >50% of missing values ($n = 216$, 0.3%), the analytical sample consisted of $n = 60{,}144$ (92.9% of the corrected sample).

Table 1. Description of individual-level data for 15-year-olds from the 2007 ESPAD (% if not otherwise indicated)

	Drunkenness at the last drinking occasion[a] [Mean (SD)]	Alcohol consumption at the last drinking occasion[b] [Mean (SD)]	Sex	Number of drinking days (30 days) [Mean (SD)]	Risk perception of consuming five or more drinks each weekend	High parental monitoring	Friends with alcohol consumption	High availability of beer
Austria	3.9 (2.7)	35.6 (40.6)	46.1	10.0 (11.9)	66.7	86.5	99.2	95.0
Belgium (Flanders)	2.6 (2.2)	34.6 (34.9)	47.8	6.5 (9.1)	66.9	89.6	98.5	90.3
Bulgaria	3.1 (2.5)	32.1 (35.1)	47.2	5.8 (9.0)	75.0	75.4	97.0	94.8
Croatia	3.9 (2.9)	28.8 (35.1)	48.1	5.2 (8.2)	74.0	75.8	98.6	94.4
Czech Republic	3.5 (2.6)	35.2 (37.9)	53.1	5.0 (7.3)	76.6	78.9	99.2	89.5
Estonia	3.7 (2.5)	40.4 (45.5)	50.8	3.1 (5.7)	79.1	68.7	98.5	84.3
Finland	3.7 (2.6)	51.3 (50.5)	55.2	2.0 (3.7)	85.6	76.1	98.4	86.4
France	3.5 (2.8)	31.5 (37.1)	45.7	7.2 (10.0)	76.7	81.7	98.1	88.3
Germany	3.3 (2.5)	33.3 (38.8)	52.3	6.6 (9.1)	75.5	86.1	99.0	95.4
Greece	2.4 (2.2)	18.4 (26.4)	53.0	5.1 (7.7)	86.1	83.5	95.9	92.2
Hungary	3.0 (2.6)	19.1 (25.6)	51.3	3.7 (7.0)	85.4	92.3	96.6	90.4
Italy	3.2 (2.8)	25.7 (32.2)	45.3	5.9 (9.2)	79.9	78.6	95.9	89.6
Lithuania	3.0 (2.4)	33.6 (40.1)	52.4	3.7 (6.7)	79.4	75.5	95.3	83.5
Netherlands	3.2 (2.4)	37.9 (40.0)	53.1	8.4 (10.9)	62.3	89.6	98.3	94.7
Norway	4.4 (2.9)	60.7 (59.7)	50.8	2.0 (3.9)	68.7	82.6	95.6	91.0
Poland	3.2 (2.5)	29.2 (30.9)	52.3	3.9 (7.1)	83.0	82.9	97.3	90.3
Romania	2.5 (2.3)	21.3 (26.6)	51.6	3.7 (7.4)	84.8	79.2	96.6	84.7
Russia	3.0 (2.3)	19.9 (24.6)	45.6	4.3 (7.6)	83.6	70.9	97.1	85.8
Slovak Republic	3.6 (2.6)	19.4 (26.7)	50.9	4.5 (7.5)	79.1	70.5	98.5	94.6
Slovenia	3.6 (2.7)	28.7 (34.5)	49.4	4.3 (7.4)	76.0	86.4	98.5	88.4
Sweden	4.1 (2.9)	46.5 (49.2)	54.1	2.3 (4.6)	80.7	80.4	97.1	90.9
Switzerland	3.3 (2.5)	29.7 (32.6)	48.4	4.5 (6.4)	79.7	79.6	98.9	94.4
Ukraine	3.1 (2.3)	26.2 (27.0)	51.8	4.6 (7.7)	81.0	74.6	97.3	89.2
UK	4.1 (2.8)	50.7 (57.1)	54.4	5.6 (8.4)	74.2	77.7	98.4	77.5
Mean (SD)	3.4 (2.6)	32.7 (39.5)	50.2	5.0 (8.1)	78.0	80.1	97.6	90.0

SD, standard deviation.
[a]Categories 1–10.
[b]In grams of ethanol.

Table 2. Description of second-level data for country characteristics

	n	Per capita consumption[a,b] (2003)	Patterns of drinking score[b,c]	Age-standardized mortality rates for liver cirrhosis[b] (2002)	Age-standardized DALYs due to alcohol use disorders[d], per 100,000 (2004)	Region
Austria	2208	11.1	1	14.6	426	Germanic countries
Belgium(Flanders)	1512	10.6	1	10.8	265	Germanic countries
Bulgaria	1876	5.9	2	12.2	368	Southern European countries
Croatia	2429	12.3	3	21.0	523	Central European countries
Czech Republic	3489	13.0	2	12.5	415	Central European countries
Estonia	2113	7.8	3	18.0	1003	Baltic countries and Russia
Finland	3801	10.5	3	9.9	687	Scandinavian countries
France	1903	11.4	1	11.4	520	Southern European countries
Germany	4382	12.0	1	14.1	519	Germanic countries
Greece	2577	9.0	2	3.7	365	Southern European countries
Hungary	2411	13.6	3	42.0	1242	Central European countries
Italy	7797	8.0	1	10.2	80	Southern European countries
Lithuania	1928	9.9	3	15.9	1030	Baltic countries and Russia
Netherlands	1782	9.7	1	3.8	499	Germanic countries
Norway	2236	6.8	3	3.9	969	Scandinavian countries
Poland	1678	8.1	3	11.5	458	Central European countries
Romania	1693	9.7	3	36.7	529	Central European countries
Russia	2442	10.3	4	20.6	1277	Baltic countries and Russia
Slovak Republic	1992	10.4	3	20.4	727	Central European countries
Slovenia	2569	6.7	3	27.9	398	Central European countries
Sweden	2111	6.6	3	3.6	766	Scandinavian countries
Switzerland	1950	10.8	1	6.6	399	Germanic countries
Ukraine	1495	6.1	3	19.9	687	Central European countries
UK	1770	11.8	3	8.3	663	Anglo-Saxon countries
Mean (SD)	2506 (1331)	9.7 (2.2)		14.5 (9.1)	569 (321)	

[a]In litres of pure ethanol.
[b]Global burden of disease analysis (World Health Organization, 2009).
[c]1 indicting the least detrimental drinking pattern and 4 indicating the most detrimental drinking pattern.
[d]Global information system on alcohol (World Health Organization, 2007).

Measures

Data were collected on two levels. At the individual level, information on alcohol consumption and other variables was taken from the ESPAD survey. Second-level data on country characteristics were retrieved from several external databases.

Student level information

Drunkenness on the last drinking occasion was assessed by asking students how drunk they were the last day they drank alcohol, using a scale from 1 ('not at all drunk') to 10 ('heavily intoxicated, for example, not remembering what happened'). Due to the subjectivity of drunkenness which limits comparability between persons and cultures, these labels were assigned to the end points of the scale in order to foster a uniform comprehension of drunkenness.

Alcohol consumption on the last drinking occasion was measured by asking students to indicate the quantity of beer, wine, spirits, alcopops (not available for France and Russia), and cider (available for Estonia, Finland, Lithuania, Norway, Poland, Slovak Republic, Sweden and UK). For beer and cider, answer categories comprised 'less than a regular bottle or can', '1–2 regular bottles or cans', '3–4 regular bottles or cans' and '>4 regular bottles or cans'. For wine and spirits, '<2 glasses/drinks', '2–3 glasses/drinks', '4–6 glasses/drinks' or '>6 glasses/drinks' could be indicated. For alcopops, categories were '<2 regular bottles', '2–3 regular bottles', '4–6 regular bottles' and '7 or more regular bottles'. To calculate the average total alcohol consumption on the latest drinking day in grams of ethanol, the mid point of the range for each response category was used, apart from the last category, in which the value of the last category plus half range to the mid point of the adjacent category was taken (Wicki *et al*., 2006). Average alcohol content was set at 4.5% for alcopops, 5% for beer and cider, 12% for wine and 38% for spirits (Hibell *et al*., 2009).

The following variables were entered into the regression analysis, with the aim of adjusting for confounders in the relationship of consumption to perceived drunkenness: gender. The number of drinking days within the last 30 days which served as an indicator of alcohol tolerance and was measured with the following categories: 0, 1–2, 3–5, 6–9, 10–19, 20–39, 40 or more. These categories were transformed into a continuous variable using the same procedure as for alcohol consumption (Wicki *et al*., 2006). Risk perception of consuming five or more drinks each weekend was dichotomized by splitting the variable into 'yes' (coded 1) for 'moderate risk' and 'great risk' and into 'no' (coded 0) for 'no risk' and 'slight risk'. Parental monitoring was addressed by the question 'Do your parents know where you spend Saturday nights?'. The scale was dichotomized by coding 'know always' and 'know quite often' into 'high parental monitoring' (coded 1) and 'know sometimes' and 'usually do not know' into 'low parental monitoring' (coded 0). In addition, students were asked how many of their friends drink alcoholic beverages. An indicator for 'friends' alcohol consumption' was created by transforming 0 into 'no' (coded 0) and 'a few', 'some', 'most' and 'all' into 'yes' (coded 1). Availability of

beer was measured by students' indication of how difficult they think it would be for them to get beer if they wanted to. The response categories 'impossible', 'very difficult' and 'fairly difficult' were merged into 'low availability' (coded 0) and the categories 'fairly easy' and 'very easy' were merged into 'high availability' (coded 1).

Country-level information

A total of five country-level variables were included in the study. The Global Information System on Alcohol and Health (GISAH, World Health Organization, 2007) provided information on the following items: per capita consumption in the general population (aged ≥15) in litres of pure alcohol in 2003, patterns of drinking score in 2002 based on different aspects of heavy drinking occasions, drinking with meals and drinking in public places (values ranging from 1 to 4 with 4 representing the most detrimental pattern) and age-standardized mortality rate of liver cirrhosis per 100,000 in 2002. The global burden of disease study (World Health Organization, 2009) provided information on age-standardized disability-adjusted life years (DALYs) due to alcohol use disorders per 100,000 in 2004. Moreover, geographic region was included as suggested by Schmid *et al.* (2003). Since Bulgaria, Croatia, Italy, the Netherlands, Romania, Slovenia and Ukraine were not included by Schmid *et al.*, these countries were categorized by the authors. Scandinavian countries comprise Finland, Norway and Sweden (coded 1), Anglo-saxon countries include the UK (coded 2), Germanic countries comprise Austria, Belgium, Germany, the Netherlands and Switzerland (coded 3), Southern European countries comprise Bulgaria, France, Greece and Italy (coded 4), Central European countries comprise Croatia, Czech Republic, Hungary, Poland, Romania, Slovak Republic, Slovenia and Ukraine (coded 5) and Baltic countries and Russia comprise Estonia, Lithuania and Russia (coded 6).

Statistical analysis

Data were structured hierarchically with students nested in classes, classes nested in schools and schools nested in countries. School as a third level was omitted since not all countries had used schools as a cluster variable in their sampling process. Thus, we applied a two-level model with students at the first and countries at the second level.

In this study, the focus was on the relationship between alcohol consumption and perceived drunkenness on the last drinking day. As the distributions of drunkenness and alcohol consumption were skewed to the right, a logarithmic transformation was used for the analysis (Bryk and Raudenbush, 1992). Coefficients for continuous variables can be interpreted as the expected proportional change in the outcome variable per proportional change in the predictor (Gelman and Hill, 2007). For example, a coefficient of 0.45 indicates that for each 1% difference in the predictor, the expected change in the outcome is 0.45%. For dichotomous variables, coefficients were exponentiated and indicate the proportional change in the outcome for a one-unit change in the predictor. Alcohol consumption was grand mean centred to facilitate interpretation (Hox, 2002).

In all regression models, perceived drunkenness was used as an outcome variable. At the individual level, all aforementioned predictors and their interactions with alcohol consumption were considered to adjust for individual factors influencing the association between alcohol consumption and perceived drunkenness. At the country level, all aforementioned predictors including cross-level interactions between country characteristics and alcohol consumption on the last drinking occasion were considered to explain between-country differences in the slopes of alcohol consumption. Significance testing of fixed parameters was done by Wald Tests. Random parameters were tested by a likelihood ratio test with halved *P*-values (Snijders and Bosker, 1994; Goldstein, 2003).

Our modelling strategy encompassed three steps: a random intercept model, a random coefficient model for alcohol consumption and a full multilevel model.

First, a random intercept model with the intercept varying across all levels was run in order to partition the variance between levels.

$$\text{Drunkenness}_{ij} = \beta_{0j} + r_{ij},$$

where β_{ij} is the intercept of student i in country j and r_{ij} is a random 'student effect'. The intercept is modelled at the country level:

$$\beta_{0j} = \gamma_{00} + \mu_{0j},$$

where γ_{00} is the grand mean and μ_{0j} is a random 'country effect'.

Secondly, a random coefficient model containing all level-1 predictors with a random intercept and a random slope for alcohol consumption was used. Interaction terms of all level-1 predictors with alcohol consumption were considered. This model aimed at investigating if there was significant country-level variation in the slope of alcohol consumption after controlling for level-1 predictors.

$$\begin{aligned}
&\text{Drunkenness}_{ij} \\
&= \beta_{0j} + \beta_{1j}\text{alc_cons}_{1ij} + \beta_{2j}\text{sex}_{2ij} + \beta_{3j}\text{sex} \\
&\times \text{alc_cons}_{3ij} + \beta_{4j}\text{freq_alc_cons}_{4ij} + \beta_{5j}\text{freq_alc_cons} \\
&\times \text{alc_cons}_{5ij} + \beta_{6j}\text{risk_5plus}_{6ij} + \beta_{7j}\text{risk_5plus} \times \text{alc_cons}_{7ij} \\
&+ \beta_{8j}\text{parent_control}_{8ij} + \beta_{9j}\text{parent_control} \times \text{alc_cons}_{9ij} \\
&+ \beta_{10j}\text{friends_alc}_{10ij} + \quad \beta_{11j}\text{friends_alc} \times \text{alc_cons}_{11ij} \\
&+ \beta_{12j}\text{avail_beer}_{12ij} + \beta_{13j}\text{avail_beer} \times \text{alc_cons}_{13ij} + r_{ij},
\end{aligned}$$

where β_{0j} is the intercept in country j, β_{pij} are the corresponding level-1 coefficients and r_{ij} is a level-1 random effect. At the country level, the β_{pij} are modelled:

$$\beta_{0j} = \gamma_{00} + \mu_{0j}$$

$$\beta_{1j} = \gamma_{10} + \mu_{1j}$$

with all other β_{pj} fixed. Here, γ_{00} is the grand mean for all countries, γ_{01} is the average alcohol consumption regression slope across countries, and μ_{0j} and μ_{1j} are random 'country effects'.

Thirdly, we calculated full multilevel models including both individual-level and country-level characteristics. Cross-level interactions between alcohol consumption and country characteristics were considered to explain the random slope variation in alcohol consumption. We first ran single predictor models, i.e. separate models for each of the five level-2 predictors and then analysed a final full multilevel model containing all significant country-level variables. At the individual level, the model corresponds to the random coefficient model at level 1. At the country level, however, the β_{pj} are modelled:

$$\begin{aligned}\beta_{0j} = {} & \gamma_{00} + \gamma_{01} \times \text{country characteristics} + \gamma_{02} \times \text{alc\_cons} \\ & \times \text{country characteristics} + \ldots + \gamma_{0p} \\ & \times \text{country characteristics} + \gamma_{0p+1} \times \text{alc\_cons} \\ & \times \text{country characteristics} + \mu_{0j}\end{aligned}$$

$$\begin{aligned}\beta_{1j} = {} & \gamma_{10} + \gamma_{11} \times \text{country characteristics} + \gamma_{12} \times \text{alc\_cons} \\ & \times \text{country characteristics} + \gamma_{1p} \\ & \times \text{country characteristics} + \gamma_{1p+1} \times \text{alc\_cons} \\ & \times \text{country characteristics} + \mu_{1j}\end{aligned}$$

with all other β_{pj} fixed.

To address concerns of missing data in the covariates, we conducted univariate regression imputation by chained equations. In concrete, the 'ice' procedure in STATA using Bayesian methods was applied (Royston, 2005). The software used was Stata 10.1 SE software package for descriptive analyses and MLwiN Version 2.02 for multilevel analyses.

RESULTS

Descriptive results

Table 1 represents individual-level data by country. Perceived drunkenness on the last drinking occasion was relatively low with an average score of 3.4 on a scale from 1 to 10. Drunkenness varied from 2.4 in Greece to 4.4 in Norway. Mean alcohol consumption on the same occasion was 32.7 g of ethanol which equals ~0.75 l of beer. Reflecting corresponding levels of drunkenness, the lowest alcohol consumption was found in Greece with 18.4 g and the highest consumption in Norway with 60.7 g of ethanol.

Table 2 shows a description of country-level characteristics. Per capita consumption in the adult population (15+) in litres of pure ethanol varied considerably around the mean consumption of 10 l. The lowest consumption level of 5.9 l was found in Bulgaria and the highest consumption level of 13.6 l was observed in the Czech Republic. The patterns of drinking score varied between 1 and 4 with 29% of the countries showing a score of 1, 13% of the countries exhibiting a score of 2, 54% having a score of 3 and 4% having a score of 4. On average, 14 persons per 100,000 died of liver cirrhosis with a variation between 4 in Sweden and 42 in Hungary. Across countries mean DALYs per 100,000 by alcohol use disorders were 569 with the lowest DALYs of 80 in Italy and the highest DALYs of 1277 in Russia.

Results of multilevel modelling

Intercept only model

Ln-transformation of drunkenness resulted in a mean of 0.9 (range: 0–2.3) and mean ln-transformed alcohol consumption was 2.7 (range: −0.1 to 5.8). Accordingly, the intercept only model revealed that the grand mean of drunkenness was 0.90 ($P < 0.001$). For the country residual error term μ_{0j}, the residual variance was statistically different from zero ($\sigma^2_{\mu_0} = 0.025$, $P < 0.001$), suggesting that drunkenness varies across countries. The intra-class correlation coefficient indicated that 3.8% of the variance in drunkenness is between countries (Bryk and Raudenbush, 1992).

Random coefficient model

Results of the random coefficient model are shown in Table 3. A 1% increase in alcohol consumption was associated with a 0.16% increase in the perception of drunkenness. At the individual level, significant interaction terms revealed that the relationship between alcohol consumption and perceived drunkenness was influenced by gender, number of drinking days, parental monitoring, friends' alcohol consumption and availability of beer. The association between alcohol intake and perceived drunkenness varies across countries, with 95% of the slopes ranging between 0.02 and 0.30.

Full multilevel models

To test whether country-level characteristics explain variation between countries, cross-level interactions were included in

Table 3. Results for random coefficient model

	Coefficients	(95% CI)	
Fixed part			
Intercept	0.73	(0.67, 0.79)	***
Alcohol consumption[a]	0.16	(0.13, 0.19)	***
Female[b]	1.07	(1.05, 1.08)	***
Number of drinking days (30 days)	0.01	(0.01, 0.01)	***
Risk perception 5plus[b]	0.92	(0.90, 0.93)	***
Parental monitoring	0.80	(0.79, 0.81)	***
Friends' alcohol consumption[b]	1.21	(1.17, 1.25)	***
Availability of beer[b]	1.13	(1.11, 1.15)	***
Female × alcohol consumption	−0.03	(−0.04, −0.02)	***
Number of drinking days × alcohol consumption	−0.002	(−0.002, −0.002)	***
Risk perception 5plus × alcohol consumption	0.01	(0.00, 0.02)	
Parental monitoring × alcohol consumption	0.02	(0.01, 0.03)	***
Friends' alcohol consumption × alcohol consumption	0.04	(0.01, 0.06)	***
Availability of beer × alcohol consumption	0.03	(0.02, 0.05)	***
Random part			
Country level			
Intercept/intercept	0.02	(0.01, 0.03)	***
Alcohol consumption/intercept	−0.002	(−0.006, 0.002)	
Alcohol consumption/alcohol consumption	0.005	(0.003, 0.007)	***
Student level			
Intercept/intercept	0.52	(0.52, 0.53)	***

CI, confidence interval.
[a]All coefficients for alcohol consumption are grand mean centred.
[b]Coefficient for categorical variable exponentiated. ***$P < 0.001$.

Table 4. Results for interaction terms of drinking patterns and geographical region with alcohol consumption in single predictor models and the final full multilevel model

Interaction of alcohol consumption with country-level predictor		Coefficients (95% CI)		Intercept for alcohol consumption	Slope for alcohol consumption
Single predictor models					
Patterns of drinking score					
1	γ_{12}	Reference group	–	0.69	0.17
2	γ_{14}	−0.04 (−0.01, 0.02)		0.62	0.13
3	γ_{16}	0.00 (−0.04, 0.04)		0.79	0.17
4	γ_{18}	−0.10 (−0.19, −0.01)	*	0.74	0.07
Region					
Scandinavian countries		Reference group	–	0.82	0.22
Anglo-Saxon countries	γ_{12}	−0.04 (−0.12, 0.05)		0.87	0.18
Germanic countries	γ_{14}	−0.04 (−0.09, 0.01)		0.67	0.18
Southern European countries	γ_{16}	−0.10 (−0.15, −0.05)	***	0.64	0.12
Central European countries	γ_{18}	−0.07 (−0.12, −0.02)	**	0.78	0.15
Baltic countries and Russia	γ_{110}	−0.08 (−0.14, −0.02)	***	0.78	0.15
Final full multilevel model					
Patterns of drinking score					
1	γ_{12}	Reference group	–	1.10	0.28
2	γ_{14}	−0.03 (−0.09, 0.03)		0.81	0.25
3	γ_{16}	−0.06 (−0.15, 0.03)		0.82	0.21
4	γ_{18}	−0.17 (−0.29, −0.06)	**	0.84	0.11
Region					
Scandinavian countries		Reference group	–	1.10	0.28
Anglo-Saxon countries	γ_{110}	−0.04 (−0.11, 0.03)		1.05	0.24
Germanic countries	γ_{112}	−0.10 (−0.20, −0.002)	*	0.67	0.18
Southern European countries	γ_{114}	−0.15 (−0.23, −0.06)	***	0.73	0.13
Central European countries	γ_{116}	−0.07 (−0.12, −0.02)	***	0.96	0.15
Baltic countries and Russia	γ_{118}	−0.08 (−0.14, −0.02)		0.90	0.24

CI, confidence interval.
***$P < 0.001$.
**$P < 0.01$.
*$P < 0.05$.

the full model. Out of five single predictor models, the models including an interaction term for the predictor drinking patterns and geographical region showed an effect on the relationship between alcohol consumption and perceived drunkenness (Table 4). Non-significant results were obtained for per capita consumption [$\beta = 0.00$ (95% confidence interval (CI):−0.01, 0.01), n.s.], standardized mortality rates for liver cirrhosis [$\beta = -0.001$ (95% CI:−0.003, 0.001), n.s.] and standardized DALYs for alcohol use disorders [$\beta = 0.00$ (95% CI: 0.00, 0.00), n.s.].

Results for interaction terms of drinking patterns and geographical region with alcohol consumption are shown in Table 4. To make interaction terms interpretable, intercepts and slopes for each group were calculated (Hox, 2002). Countries that are characterized by a pattern of drinking score of 4 showed smaller slopes and higher intercepts than countries characterized by a score of 1. This indicates that the relationship between alcohol consumption and perceived drunkenness was weaker and the mean perceived drunkenness higher in countries with the most detrimental drinking pattern than in countries with the least detrimental drinking pattern. Compared with Scandinavian countries, Southern European countries, Central European countries and the Baltic countries and Russia exhibited smaller slopes and intercepts. Thus, the relationship between alcohol consumption and perceived drunkenness was weaker and the mean perceived drunkenness was lower in these countries. Concerning individual-level predictors, significance levels did not change after the introduction of country-level predictors.

The final full multilevel model containing the predictor drinking patterns and region showed similar results for drinking patterns but different results for region (Table 4). While Southern and Central European countries still showed smaller slopes and intercepts than Scandinavian countries, coefficients for Baltic countries and Russia were not significant. Instead, the relationship between alcohol consumption and perceived drunkenness was weaker and the mean perceived drunkenness was lower in Germanic countries.

DISCUSSION

We believe this is the first study analysing measures of alcohol consumption and perceived drunkenness relating to the same drinking occasion. Results revealed cross-country variation in the relationship between alcohol consumption and perceived drunkenness among adolescents. This variation was partly explained by drinking patterns and the geographical region; it occurred after adjusting for confounding variables at the individual level. An increase of 0.16% in the perception of drunkenness per 1% increase in alcohol consumption may appear small. However, it has to be noted that 1% of the mean alcohol consumption equals only 0.327 g of ethanol (8.2 ml of beer).

Results showed that in Russia, which exhibits the most detrimental drinking pattern, i.e. a high proportion of heavy drinkers, drinking outside of meals and drinking in public, the relationship between alcohol consumption and perceived

drunkenness among adolescents is weaker than in countries characterized by the least detrimental drinking pattern such as Italy or the Netherlands. However, since it is unclear how drinking patterns in the adult population relate to drinking patterns of adolescents (Room, 2007), it remains to be clarified if differences in perception are due to differences in drinking patterns of adolescents or to differences at the country level, such as drinking norms.

For geographical region, results of the full multilevel model indicated weaker relationships between alcohol consumption and perceived drunkenness in Southern European, Central European and Germanic countries compared with Scandinavian countries. Schmid *et al*. (2003) also found a stronger relationship between frequency of alcohol consumption and frequency of intoxication among adolescents in Nordic countries when compared with those in Southern European countries. However, our results indicated differences for Central European and Germanic countries that did not emerge in the former study. Note that disparities between the full multilevel model and the single predictor models may be due to covariance of drinking patterns and region.

To explain their results Schmid *et al*. (2003) suggested that 'geographical region […] may be a proxy for the different drinking cultures in Nordic and Southern European countries' (p. 659). Similarly, Room (2007) pointed out that the most important contrast in drinking 'has been between Southern European wine cultures and "the rest"' (p. 2). Since the term 'culture' is often used in a broad and general way (Dressler, 2006), it is not clear which aspect of culture, i.e. drinking norms, alcohol consumption or a combination of different aspects, accounts for the differences. For example, there is evidence that drinking norms might explain differences in the perception of drunkenness (Kitano *et al*., 1992; Nagoshi *et al*., 1994). Qualitative studies indicate that drinking to get drunk and going over board were behaviours that were disapproved of by young Italians (Beccaria and Guidoni, 2002), while Danish teenagers tended to hold positive associations for drunkenness such as sociability and time out (Demant and Järvinen, 2006). Also, differences in drinking situations exist between countries (Rehm *et al*., 2001; Currie *et al*., 2008). In 'wet' or Mediterranean drinking cultures, alcohol is mainly consumed with meals in moderate amounts (Room and Mäkelä, 2000). In contrast, in 'dry' or northern drinking cultures, drinking is traditionally constrained to festivals and weekends and high amounts of alcohol are consumed (Room, 2001). Although the distinction between 'wet' and 'dry' cultures and its associated alcohol use is close to the notion of drinking patterns, the former is based on deep-rooted cultural traits (Room, 2007), which results in a different classification of countries.

Evidence for distinct alcohol consumption behaviour and norms in Germanic or Central European countries is less clear. However, consistent with our findings, beer-drinking countries such as Germany or the Netherlands are considered to have an intermediate position between Southern and Northern European countries regarding heavy drinking and drinking norms (Room, 2007). For example, Leifman (2002) found in a comparative analysis of drinking frequency and quantity per occasion that Germany ranged between Finland and Italy. In Central European countries, great variation in drinking cultures can be found. For example, the Czech Republic's drinking pattern is characterized by beer drinking and is very similar to the Germanic one. Poland, in contrast, resembles the Northern European pattern and Romania shows the Mediterranean wine drinking pattern (Popova *et al*., 2007). Our findings might be explained by the fact that three of these eight countries are characterized by a Mediterranean drinking style, namely Hungary, Slovenia and Romania.

Results of this study suggest that drinking patterns prevailing in a society and geographical region influence the perception of drunkenness. However, it is not clear what these factors represent, i.e. drinking norms, drinking practices etc. Room (2001) notes that the socio-cultural mechanisms that support the cultural framing of drunkenness need to be explored. Identifying specific cultural aspects such as drinking norms may help to better understand adolescent' drinking and the perception of the felt effects of it. Thus, research is needed to identify cultural mechanisms which could account for these differences, and effort should be put in the development of indicators representing relevant country characteristics.

Our study has limitations. First, given that drunkenness is subjective (Cameron *et al*., 2000; Midanik, 2003), interpretation of our findings relies on the assumption that all individuals across all countries conceptualize drunkenness in the same way. However, evidence from qualitative studies casts doubt on this issue. For example, adolescents in Italy reported a negative valence of drunkenness (Beccaria and Guidoni, 2002), while adolescents in Denmark rather attributed a positive valence (Järvinen and Room, 2007). Although labels were assigned to the end points of the scale ('not at all drunk' and 'heavily intoxicated, for example, not remembering what happened') to foster similar conceptualizations, success of this endeavour cannot be proven. Therefore, different concepts of drunkenness across cultures may exist and the variation in the relationship of alcohol consumption and drunkenness might reflect differences in the outcome threatening the validity of our results. Secondly, country factors might not only have influenced the perception of drunkenness but also the reporting of drunkenness. Yet, students were assured confidentiality at all stages of the study. Thirdly, we may have omitted important factors at the individual level as well as at the country level that might bias our results. At the individual level, for example, personality or drinking context influence alcohol consumption and perceived drunkenness and might as well affect the association of both. Nonetheless, our analysis is the first to control for confounding variables at the individual level, and different country factors were included into our analyses. Fourthly, reliability and validity of the included country-level variables might vary due to differences in data quality (World Health Organization, 2004). In addition, some of our variables may not mirror reality in 2007, diminishing the explanatory power of these variables. For example, the patterns of drinking score were constructed in 2002. However, as changes in drinking culture usually occur slowly (Room, 2007), this is supposed to have a minor impact.

CONCLUSION

The perception of the effects of alcohol in terms of drunkenness seems to vary across countries. Some of the variation is

due to drinking patterns and geographical region. However, the socio-cultural mechanisms that are hidden behind these country factors remain unclear. Sound indicators for cultural differences should be developed in order to explain differences between countries.

Acknowledgements — The international data set of the 2007 ESPAD survey was compiled by Thoroddur Bjarnason (University of Akureyri, Iceland), supported by a team of ESPAD researchers. National collaborating persons (including Principal Investigators), funding agencies and supportive organizations are listed in (Hibell *et al*., 2009, p. 186–188).

Conflict of interest statement. None declared.

Funding — Data for this paper were provided by the European School Survey Project on Alcohol and Other Drugs (ESPAD) led by Björn Hibell and funded by the Swedish Council on Information on Alcohol and Other Drugs (CAN).

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