COGNITIVE ASPECTS

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

Stefanie Müller*, Daniela Piontek, Alexander Pabst and Ludwig Kraus

IFT Institut für Therapieforschung, Parzivalstraße 25, D-80804 München, Germany
*Corresponding author. Tel.: +49-89-36-08-04-32; Fax: +49-89-36-08-04-49; E-mail: mueller@ift.de

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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.
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).

<p>| 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 | Alcohol consumption at the last drinking occasion | Number of drinking days (30 days) | Risk perception of consuming five or more drinks each weekend |</p>
<table>
<thead>
<tr>
<th>Sex</th>
<th>Mean (SD)</th>
<th>Mean (SD)</th>
<th>[Mean (SD)]</th>
<th>[Mean (SD)]</th>
<th>[Mean (SD)]</th>
<th>[Mean (SD)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>3.9 (2.7)</td>
<td>35.6 (40.6)</td>
<td>46.1</td>
<td>10.0 (11.9)</td>
<td>66.7</td>
<td>86.5</td>
</tr>
<tr>
<td>Belgium (Flanders)</td>
<td>2.6 (2.2)</td>
<td>34.6 (34.9)</td>
<td>47.8</td>
<td>6.5 (9.1)</td>
<td>66.9</td>
<td>89.6</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>3.1 (2.5)</td>
<td>32.1 (35.1)</td>
<td>47.2</td>
<td>5.8 (9.0)</td>
<td>75.0</td>
<td>75.4</td>
</tr>
<tr>
<td>Croatia</td>
<td>3.9 (2.9)</td>
<td>28.8 (35.1)</td>
<td>48.1</td>
<td>5.2 (8.2)</td>
<td>74.0</td>
<td>75.8</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>3.5 (2.6)</td>
<td>35.2 (37.9)</td>
<td>53.1</td>
<td>5.0 (7.3)</td>
<td>76.6</td>
<td>78.9</td>
</tr>
<tr>
<td>Estonia</td>
<td>3.7 (2.5)</td>
<td>40.4 (45.5)</td>
<td>50.8</td>
<td>3.1 (5.7)</td>
<td>79.1</td>
<td>68.7</td>
</tr>
<tr>
<td>Finland</td>
<td>3.7 (2.6)</td>
<td>51.3 (50.5)</td>
<td>55.2</td>
<td>2.0 (3.7)</td>
<td>85.6</td>
<td>76.1</td>
</tr>
<tr>
<td>France</td>
<td>3.5 (2.8)</td>
<td>31.5 (37.1)</td>
<td>45.7</td>
<td>7.2 (10.0)</td>
<td>76.7</td>
<td>81.7</td>
</tr>
<tr>
<td>Germany</td>
<td>3.3 (2.5)</td>
<td>33.3 (38.8)</td>
<td>52.3</td>
<td>6.6 (9.1)</td>
<td>75.5</td>
<td>86.1</td>
</tr>
<tr>
<td>Greece</td>
<td>2.4 (2.2)</td>
<td>18.4 (26.4)</td>
<td>53.0</td>
<td>5.1 (7.7)</td>
<td>86.1</td>
<td>83.5</td>
</tr>
<tr>
<td>Hungary</td>
<td>3.0 (2.6)</td>
<td>19.1 (25.6)</td>
<td>51.3</td>
<td>3.7 (7.0)</td>
<td>85.4</td>
<td>92.3</td>
</tr>
<tr>
<td>Italy</td>
<td>3.2 (2.8)</td>
<td>25.7 (32.2)</td>
<td>45.3</td>
<td>5.9 (9.2)</td>
<td>79.9</td>
<td>78.6</td>
</tr>
<tr>
<td>Lithuania</td>
<td>3.0 (2.4)</td>
<td>33.6 (40.1)</td>
<td>52.4</td>
<td>3.7 (6.7)</td>
<td>79.4</td>
<td>75.5</td>
</tr>
<tr>
<td>Netherlands</td>
<td>3.2 (2.4)</td>
<td>37.9 (40.0)</td>
<td>53.1</td>
<td>8.4 (10.9)</td>
<td>62.3</td>
<td>89.6</td>
</tr>
<tr>
<td>Norway</td>
<td>4.4 (2.9)</td>
<td>60.7 (59.7)</td>
<td>50.8</td>
<td>2.0 (3.9)</td>
<td>68.7</td>
<td>82.6</td>
</tr>
<tr>
<td>Poland</td>
<td>3.2 (2.5)</td>
<td>29.2 (30.9)</td>
<td>52.3</td>
<td>3.9 (7.1)</td>
<td>83.0</td>
<td>82.9</td>
</tr>
<tr>
<td>Romania</td>
<td>2.5 (2.3)</td>
<td>21.3 (26.6)</td>
<td>51.6</td>
<td>3.7 (7.4)</td>
<td>84.8</td>
<td>79.2</td>
</tr>
<tr>
<td>Russia</td>
<td>3.0 (2.3)</td>
<td>19.9 (24.6)</td>
<td>45.6</td>
<td>4.3 (7.6)</td>
<td>83.6</td>
<td>70.9</td>
</tr>
<tr>
<td>Slovak Republic</td>
<td>3.6 (2.6)</td>
<td>19.4 (26.7)</td>
<td>50.9</td>
<td>4.5 (7.5)</td>
<td>79.1</td>
<td>70.5</td>
</tr>
<tr>
<td>Slovenia</td>
<td>3.6 (2.7)</td>
<td>28.7 (34.5)</td>
<td>49.4</td>
<td>4.3 (7.4)</td>
<td>76.0</td>
<td>86.4</td>
</tr>
<tr>
<td>Sweden</td>
<td>4.1 (2.9)</td>
<td>46.5 (49.2)</td>
<td>54.1</td>
<td>2.3 (4.6)</td>
<td>80.7</td>
<td>80.4</td>
</tr>
<tr>
<td>Switzerland</td>
<td>3.3 (2.5)</td>
<td>29.7 (32.6)</td>
<td>48.4</td>
<td>4.5 (6.4)</td>
<td>79.7</td>
<td>79.6</td>
</tr>
<tr>
<td>Ukraine</td>
<td>3.1 (2.3)</td>
<td>26.2 (27.0)</td>
<td>51.8</td>
<td>4.6 (7.7)</td>
<td>81.0</td>
<td>74.6</td>
</tr>
<tr>
<td>UK</td>
<td>4.1 (2.8)</td>
<td>50.7 (57.1)</td>
<td>54.4</td>
<td>5.6 (8.4)</td>
<td>74.2</td>
<td>77.7</td>
</tr>
<tr>
<td>Mean (SD)</td>
<td>3.4 (2.6)</td>
<td>32.7 (39.5)</td>
<td>50.2</td>
<td>5.0 (8.1)</td>
<td>78.0</td>
<td>80.1</td>
</tr>
</tbody>
</table>

SD, standard deviation.

*aCategories 1–10.

*bIn grams of ethanol.
To calculate the average total alcohol consumption on the bottles pops, categories were 'drinks', 'cans' or 'cider, answer categories comprised Poland, Slovak Republic, Sweden and UK). For beer and wine, spirits, alcopops (not available for France and Russia), measured by asking students to indicate the quantity of beer, to foster a uniform comprehension of drunkenness.

Due to the subjectivity of drunkenness which could be indicated. For alco-

---|---|---|---|---
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 | 12.5 | 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 | 1902 | 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) |

In litres of pure ethanol.

Global burden of disease analysis (World Health Organization, 2009).

1(indicating the least detrimental drinking pattern and 4 indicating the most detrimental drinking pattern.

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 ‘4–6 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
beaver 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 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 \(\beta_{0j}\) 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 \(\gamma_{00}\) is the grand mean and \(\mu_{0j}\) 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.

\[
\begin{align*}
\text{Drunkenness}_{ij} &= \beta_{0j} + \beta_{1j}\text{alc cons}_{ij} + \beta_{2j}\text{sex}_{2ij} + \beta_{3j}\text{sex}_{3ij} \\
&\quad \times \text{alc cons}_{3ij} + \beta_{4j}\text{freq alc cons}_{4ij} + \beta_{5j}\text{freq alc cons} \\
&\quad \times \text{alc cons}_{5ij} + \beta_{6j}\text{risk 5 plus}_{6ij} + \beta_{7j}\text{risk 5 plus}_{7ij} \times \text{alc cons}_{7ij} \\
&\quad + \beta_{8j}\text{parent control}_{8ij} + \beta_{9j}\text{parent control} \times \text{alc cons}_{9ij} \\
&\quad + \beta_{10j}\text{friends alc}_{10ij} + \beta_{11j}\text{friends alc} \times \text{alc cons}_{11ij} \\
&\quad + \beta_{12j}\text{avail beer}_{12ij} + \beta_{13j}\text{avail beer} \times \text{alc cons}_{13ij} + r_{ij},
\end{align*}
\]

where \(\beta_{0j}\) is the intercept in country \(j\), \(\beta_{pji}\) are the corresponding level-1 coefficients and \(r_{ij}\) is a level-1 random effect. At the country level, the \(\beta_{pji}\) are modelled:

\[
\begin{align*}
\beta_{0j} &= \gamma_{00} + \mu_{0j} \\
\beta_{pji} &= \gamma_{1pi} + \mu_{pji},
\end{align*}
\]

with all other \(\beta_{pji}\) fixed. Here, \(\gamma_{01}\) is the grand mean for all countries, \(\gamma_{10}\) is the average alcohol consumption regression slope across countries, and \(\mu_{0j}\) and \(\mu_{pji}\) 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 $\beta_{ij}$ are modelled:

$$\beta_{ij} = \gamma_{i0} + \gamma_{i1} \times \text{country characteristics} + \gamma_{i2} \times \text{alc_cons}$$

with all other $\beta_{ij}$ 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 101. The lowest consumption level of 5.91 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: 0.25, 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 $\mu_{ij}$ the residual variance was statistically different from zero ($\sigma^{2}_{\mu} = 0.025, P < 0.001$), 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 the model.

Table 3. Results for random coefficient model

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixed part</td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.73</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>0.16</td>
</tr>
<tr>
<td>Female</td>
<td>1.07</td>
</tr>
<tr>
<td>Number of drinking days (30 days)</td>
<td>0.01</td>
</tr>
<tr>
<td>Risk perception 5plus</td>
<td>0.92</td>
</tr>
<tr>
<td>Parental monitoring</td>
<td>0.80</td>
</tr>
<tr>
<td>Friends’ alcohol consumption</td>
<td>1.21</td>
</tr>
<tr>
<td>Availability of beer</td>
<td>1.13</td>
</tr>
<tr>
<td>Female × alcohol consumption</td>
<td>−0.03</td>
</tr>
<tr>
<td>Number of drinking days × alcohol consumption</td>
<td>−0.002</td>
</tr>
<tr>
<td>Risk perception 5plus × alcohol consumption</td>
<td>0.01</td>
</tr>
<tr>
<td>Parental monitoring × alcohol consumption</td>
<td>0.02</td>
</tr>
<tr>
<td>Friends’ alcohol consumption × alcohol consumption</td>
<td>0.04</td>
</tr>
<tr>
<td>Availability of beer × alcohol consumption</td>
<td>0.03</td>
</tr>
</tbody>
</table>

Random part

<table>
<thead>
<tr>
<th>Coefficients</th>
<th>(95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Country level</td>
<td></td>
</tr>
<tr>
<td>Intercept/intercept</td>
<td>0.02</td>
</tr>
<tr>
<td>Alcohol consumption/intercept</td>
<td>−0.002</td>
</tr>
<tr>
<td>Alcohol consumption/intercept</td>
<td>0.005</td>
</tr>
<tr>
<td>Student level</td>
<td></td>
</tr>
<tr>
<td>Intercept/intercept</td>
<td>0.52</td>
</tr>
</tbody>
</table>

CI, confidence interval.

*All coefficients for alcohol consumption are grand mean centred.

**Coefficient for categorical variable exponentiated. ***$P < 0.001$.**
Single predictor models

Patterns of drinking score

| 1 | γ12 | Reference group | – | 0.69 | 0.17 |
| 2 | γ14 | –0.04 (–0.01, 0.02) | – | 0.62 | 0.13 |
| 3 | γ16 | 0.00 (–0.04, 0.04) | – | 0.79 | 0.17 |
| 4 | γ18 | –0.10 (–0.19, –0.01) | * | 0.74 | 0.07 |

Region

Scandinavian countries

| 1 | γ12 | Reference group | – | 0.82 | 0.22 |
Anglo-Saxon countries

| 2 | γ14 | –0.04 (–0.12, 0.05) | – | 0.87 | 0.18 |
Germanic countries

| 3 | γ16 | –0.04 (–0.09, 0.01) | – | 0.67 | 0.18 |
Southern European countries

| 4 | γ18 | –0.10 (–0.15, –0.05) | *** | 0.64 | 0.12 |
Central European countries

| 110 | γ18 | –0.07 (–0.12, –0.02) | ** | 0.78 | 0.15 |
Baltic countries and Russia

| –0.08 (–0.14, –0.02) | *** | 0.78 | 0.15 |

Final full multilevel model

Patterns of drinking score

| 1 | γ12 | Reference group | – | 1.10 | 0.28 |
| 2 | γ14 | –0.03 (–0.09, 0.03) | – | 0.81 | 0.25 |
| 3 | γ16 | –0.06 (–0.15, 0.03) | – | 0.82 | 0.21 |
| 4 | γ18 | –0.17 (–0.29, –0.06) | ** | 0.84 | 0.11 |

Region

Scandinavian countries

| 110 | γ12 | Reference group | – | 1.10 | 0.28 |
Anglo-Saxon countries

| 2 | γ14 | –0.04 (–0.11, 0.03) | – | 1.05 | 0.24 |
Germanic countries

| 3 | γ16 | –0.10 (–0.20, –0.002) | * | 0.67 | 0.18 |
Southern European countries

| 4 | γ18 | –0.15 (–0.23, –0.06) | *** | 0.73 | 0.13 |
Central European countries

| 116 | γ16 | –0.07 (–0.12, –0.02) | *** | 0.96 | 0.15 |
Baltic countries and Russia

| –0.08 (–0.14, –0.02) | *** | 0.90 | 0.24 |

Intercept for alcohol consumption

| 0.69 | 0.17 |
| 0.62 | 0.13 |
| 0.79 | 0.17 |
| 0.74 | 0.07 |

Slope for alcohol consumption

| 0.17 | 0.03 |
| 0.18 | 0.01 |
| 0.25 | 0.01 |
| 0.21 | 0.02 |

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 [β = 0.00 (95% confidence interval (CI):–0.01, 0.01), n.s.], standardized mortality rates for liver cirrhosis [β = –0.001 (95% CI:–0.003, 0.001), n.s.] and standardized DALYs for alcohol use disorders [β = 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 was weaker and the mean perceived drunkenness was lower than in countries with the least detrimental drinking pattern.
Alcohol consumption and perceived drunkenness

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

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