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Adolescent alcohol use: a reflection of national drinking patterns and policy?

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Abstract

Aims—To analyse how adolescent drunkenness and frequency of drinking were associated with adult drinking patterns and alcohol control policies.

Design, Setting and Participants—Cross-sectional survey data on 13- and 15-year-olds in 37 countries who participated in the Health Behaviour in School-Aged Children (HBSC) Study in 2010 ($n = 144\,788$) were linked to national-level indicators on alcohol control policies and adult drinking patterns.

Measurements—Outcome measures were self-reported weekly drinking and life-time drunkenness (drunk once or more). Data were analysed using multi-level logistic regression models.

Findings—In the mutually adjusted models, adolescent drunkenness was associated significantly with high adult alcohol consumption [odds ratio (OR) = 3.15 among boys, 95% confidence interval (CI) = 2.13–4.64, OR girls = 2.44, CI = 1.57–3.80] and risky drinking patterns in the adult population (OR boys = 2.02, CI = 1.33–3.05, OR girls = 1.61, CI = 1.18–2.18). The level of abstainers in the adult population was also associated significantly with girls' drunkenness; a 10%

increase in the number of abstainers in a country reduced the odds of drunkenness with 21% (OR = 0.79, CI = 0.68–0.90). Weekly drinking was associated significantly with weak restrictions on availability (OR boys = 2.82, CI = 1.74–4.54, OR girls = 2.00, CI = 1.15–3.46) and advertising (OR boys = 1.56, CI = 1.02–2.40, OR girls = 1.79, CI = 1.10–2.94).

Conclusions—Comparing data cross-nationally, high levels of adult alcohol consumption and limited alcohol control policies are associated with high levels of alcohol use among adolescents.

Keywords

Adolescents; alcohol control policies; alcohol use; country-level predictors; cross-national studies; minimum purchasing age

INTRODUCTION

Excessive alcohol use in adolescence is associated with a range of adverse effects, including brain damage, academic failure, violence, injuries, unprotected sexual intercourse and later excessive use, alcoholism and early mortality [1–7]. Within Europe, there are large variations in rates of drunkenness and frequency of drinking among adolescents [8–10]. With some exceptions, drunkenness is more prevalent in northern Europe, while southern Europe has a higher prevalence of frequent drinking [6,8,9,11,12]. Insight into factors associated with these cross-national differences may help understanding of the aetiology of adolescents' alcohol use. Adult drinking patterns and alcohol control policies have been hypothesized to contribute to the cross-country variation in adolescent alcohol use [13–15], but few studies have addressed this issue.

Adolescents' alcohol use is influenced by the context in which they live [16–18]. According to Skog's theory of collective consumption [18], each person tends to adjust his or her alcohol consumption to other people within the same culture, i.e. the population tends to behave collectively. One might therefore expect adolescents' alcohol consumption to reflect the consumption pattern and drinking culture in their country [19,20]. This assumption has received little attention in international research [16]. The few available studies are based mainly on ecological analyses [13,14] and use per capita alcohol intake as a proxy for the alcohol culture [13,21–23]. Other aspects of adult drinking might also be relevant, e.g. the proportion of abstainers and proportion of binge drinkers in each country. There are wide variations across countries in the rate of alcohol abstinence; for example, 0.8% of the Danish population are life-time abstainers, where the corresponding percentage in Portugal is 26% [24].

Country differences in alcohol control policies, such as minimum purchasing age and restrictions on availability and advertising, is another potential explanation for the variation in adolescent drinking. Almost all European and North American countries have minimum purchasing ages (MPA) for alcohol, typically from 16 to 21 years [25]. Although many young people succeed in buying alcohol despite age limits [26,27], the general observation is that low MPA is associated with a higher proportion of young people who buy and drink alcohol [28–31] and the proportion who experience problems from their alcohol use such as injuries and drunk driving [32–35]. Restrictions on advertising and availability have also

been used to reduce alcohol consumption and related harm among adolescents [28,36]. Higher outlet density has been associated with higher alcohol consumption and a range of adverse outcomes [37,38]. There are considerable variations in alcohol control policies across states [33,39] and countries [22,36,40]. Few studies have examined whether these variations are related to alcohol use among adolescents [15]. Previous research has been carried out mainly in single countries [15], with use of aggregated data [14,21,36] and dichotomous measures (e.g. absent/present) of alcohol control policies. To gain a more comprehensive measure of alcohol control policy, Brand *et al.* [36] developed the Alcohol Policy Index (API) with five regulatory domains: (i) availability of alcohol, (ii) drinking context (e.g. community mobilization programmes), (iii) alcohol prices, (iv) advertising and (v) operation of motor vehicles (e.g. legal blood alcohol limit, random breath testing).

In this study, we aimed to analyse how adolescent drunkenness and frequency of drinking were associated with adult drinking patterns and alcohol control policies, and whether these variables accounted for any of the country-level variations in adolescent alcohol use. We included two outcome measures: (i) drunk one or more times and (ii) drinking weekly or more often. We explored gender differences in these associations, because alcohol use among boys and girls might be associated differently with country-level factors [22]. Despite evidence of gender convergence in adolescents' drinking, there are still differences in the prevalence of drunkenness and weekly drinking among boys and girls [8,41]. Social sanctions are perceived to be greater for women drinking than for men drinking [42], and drinking and drunkenness are generally viewed as more socially acceptable for boys than girls [43,44].

METHODS

The Health Behaviour in School-aged Children (HBSC) study

We used data from the HBSC study, 2009/10 [8]. HBSC provides comparable data on young people's health and health behaviours. The study population comprises nationally or regionally representative samples of schoolchildren in three age groups: 11-, 13- and 15-year-olds recruited from schools or school classes. The students answered the internationally standardized HBSC questionnaire at school; in some countries a paper-and-pencil version and in others a computer-based questionnaire were used. The study adheres to national regulations of research ethics and data protection. Some countries required parental consent, while other countries followed other practices, e.g. the parents' board provided consent on behalf of all parents. Participation in the survey was voluntary. Students received oral and written information on the confidentiality of their responses. Countries were required to follow the international research protocol, which prescribes consistency in sampling plans, survey instruments and data collection. Overall, the proportion of sampled schools which participated in the study varied from 42 to 100% across countries, with a mean of 81%. Non-participating schools usually claimed that they were too busy or had participated recently in another health survey. Student responses were high, with a mean response rate of 79% (calculations based on 31 countries). Each participating country obtained approval to conduct the survey from the relevant ethics review board or equivalent regulatory institution [8,45]. Further information can be found in Roberts and colleagues [45] and online [46].

Study population

We used data on 13- and 15-year-olds ($n = 145\,671$). Countries with no information on alcohol use (Turkey) or missing data on adult drinking patterns (Greenland) were excluded ($n = 5299$), as were students with missing information on age (1952) or alcohol measures ($n = 1810$), leaving 144 788 students for further analyses. Table 1 shows the 37 countries in the study. Analyses that included policy restrictions were restricted to 27 countries with available API scores ($n = 104\,676$).

We merged individual-level data from HBSC on frequency of alcohol use, drunkenness and individual-level socio-demographic factors [8], and data on country characteristics retrieved from the Global Information System on Alcohol and Health (GISAH) [47] and World Health Organization (WHO) [24,48].

Individual-level factors

Weekly drinking was assessed by asking students how often they drank beer, wine, alcopops and liquor/spirits. Those who answered 'every week' or 'every day' for at least one type of alcoholic drink were categorized as weekly drinkers (coded 1). Drunkenness was measured with the item: 'Have you ever been really drunk?' ('no, never', 'yes, once', 'yes, two or three times', 'yes, four to 10 times' and 'yes, more than 10 times'). Answers were categorized as 'once or more' (coded 1) versus 'never'. Gender (girls as the reference) and age group (13-year-olds as the reference) were included as covariates.

Adult drinking patterns

We included five measures of adult drinking patterns based on data from WHO [24,47,48]. Rate of life-time abstainers was calculated from data collected in 2005 or 2009. Pattern of drinking scores (PDS) was assessed in 2004/05 by WHO. PDS is based on an array of drinking attributes and weighted into a PDS scale from 1 (least) to 5 (most risky pattern of drinking). We categorized PDS into low = 1, medium = 2 and high risk = 3–5, with low-risk countries as the reference [49]. Adult alcohol per capita consumption (APCC) was measured in litres of pure alcohol per person (aged 15) per year, including estimated unrecorded alcohol intake for 2005 and the average recorded alcohol intake for 2003/05. Alcohol per capita consumption among drinkers (APCCD) was measured as litres of pure alcohol consumed per year only by the adult drinking population in 2005. Male binge drinkers was measured in 2003/05 as those who drank 60 g or more of pure alcohol on one occasion during the past 7 days.

Alcohol control policies

We included four country-level variables concerning alcohol control policies. Minimum purchase age (MPA) was derived from WHO [47,48] and measured in 2008 as the lowest MPA for buying any type of alcohol (no age limit, 16 years, 18 years and 20–21 years). Three other measures of policy restrictions were derived from the Alcohol Policy Index (API) [36]: (i) total API indicates the comprehensiveness of the overall alcohol control policies and ranged from 0 to 68, (ii) availability API based on minimum purchase age, hours of sales (range 0–24) and (iii) advertising API based on number of media with

advertising restrictions (range 0–3). For all three indexes a higher score indicated more restrictive policies. Total API and availability API were split into approximate tertiles and categorized from 1 to 3 (most restrictive policies). The variables concerning alcohol control policies were modelled with the strongest policy used as the reference group.

Analysis

Sex- and age-adjusted multi-level analysis—Univariate age- and sex-adjusted multi-level logistic regression models were conducted with SAS version 9.3 to examine the relationships of adolescent alcohol use with adult drinking patterns and alcohol control policies. We applied a two-level random intercept model with students (level 1) nested in countries (level 2). Analyses were repeated in a three-level model which also included the school level. Estimates of the fixed effects were almost similar in the two-level model. Because of heterogeneity in the school variable across countries, and because of the similar results from two- and three-level models, the school level was omitted in the multi-level model.

Separate models were run for each outcome variable adjusted for age and sex. We performed sex-stratified analyses when there was significant ($P < 0.05$) interaction with gender (indicated with * in Table 2). These results are presented in the Appendix. Further, we repeated the analyses with different cut-points for lifetime drunkenness: drunk twice or more and four or more times.

Multivariable multi-level analysis—We also examined results for a final mutually adjusted multi-level model including significant country-level measures to assess the strength of each contextual measure in the presence of the others. Only significant associations were retained in the model. These analyses were stratified by sex. To further explore the gender differences, a combined variable of country-level availability and gender was constructed. We included interaction terms between age and main effects in the analyses. Non-significant interaction terms were deleted from the model.

Median odds ratio (MOR), intraclass correlation (ICC) and goodness-of-fit (GOF) were calculated to assess the extent to which adult drinking and alcohol control policies accounted for country-level variation in adolescent alcohol and to assess the fit of the model. MOR translates the country-level variance into the odds ratio (OR) scale and is directly comparable with the ORs of individual covariates [50]. In this study, MOR shows the extent to which the individual probability of drunkenness and weekly drinking are associated with country. The ICC measures the proportion of the variance in adolescent alcohol use that is due to country-level variation. To assess to what extent the country-level variables accounted for the variation in alcohol use across countries, the MOR and ICC were calculated with and without explanatory country-level variables. GOF and number of iterations were reported in Tables 3 and 4. GOF was evaluated by using the dispersion parameter. A value close to 1 indicates a satisfactory fit, meaning that the variability has been modelled correctly and that there is no residual overdispersion.

RESULTS

Descriptive results

Table 1 shows individual- and country-level characteristics. Among 13-year-olds the overall prevalence of drunkenness and weekly drinking were 18.3 and 7.8%, respectively. The corresponding figures for 15-year-olds were 46.5 and 21.1%. There were large variations in prevalence of drunkenness and weekly drinking across countries. As an example, 5.6% of the 13-year-olds reported drunkenness in Iceland compared to 34.5% in Wales. Life-time abstainers varied from 0.8% in Denmark to 40.5% in Macedonia and Israel. APCC in the adult population varied considerably, from 2.9 l in Israel to 16.5 l in the Czech Republic. APCCD varied from 5.5 l in Israel to 27.9 l in Ukraine. The average percentage of male binge drinking ranged from 2.3% in Sweden to 43.4% in Ireland. Patterns of drinking score varied between 1 and 3 with a mean of 2.4, most countries having a score of 3. Across-countries mean total API was 40.9, with the lowest score in Luxembourg (score 14) and the highest scores of 64–67 in Sweden, Norway, Iceland and Poland. Iceland, United States and Canada had the most restrictive availability policy (scores of 21–24), while Austria, Italy, Luxembourg and Portugal had the least restrictive policy. The index on advertising restrictions ranged from 0 to 3, with most countries having limited restrictions.

Sex- and age-adjusted multi-level analyses

The univariate analyses (sex- and age-adjusted) showed that high per capita consumption, high proportion of binge drinking, high PDS score, fewer restrictions on MPA and high availability were associated significantly with high levels of adolescent drunkenness. The association between drunkenness and country-level factors were stable across different cut-points and showed the same tendency. The following measures were associated significantly with high levels of weekly drinking among adolescents: high availability, fewer restrictions on MPA and low API scores (Table 2).

We found significant gender differences in 10 of the univariate models (indicated with * in Table 2). Stratified analyses were performed when interaction was found (see Appendix). Level of abstainers, level of male binge drinking and advertising restrictions were associated significantly with drunkenness among girls only, while MPA was associated significantly with boys' drunkenness only. Advertising restrictions were associated significantly with weekly drinking among girls only, while the association between alcohol control policies and weekly drinking was significant for boys only. The association between availability policies and weekly drinking was significant for boys and girls with slightly higher ORs among the boys (Fig. 1).

Multivariable multi-level analyses

High APCC and PDS were associated significantly with drunkenness for both genders (Table 3). As an example, boys in countries with high compared to low levels of APCC had an OR of 3.15 [95% confidence interval (CI) = 2.13–4.64] for drunkenness. For girls, the level of abstainers was associated significantly negatively with drunkenness. A 10% increase in number of abstainers corresponded to a 21% reduction in the risk of drunkenness ($P = 0.001$).

Availability policies and advertising were associated significantly with weekly drinking among boys and girls (Table 4). Girls in countries with few restrictions on alcohol availability had elevated odds of weekly drinking (OR = 2.00, 95% CI = 1.15–3.46), as had boys (OR = 2.82, 95% CI = 1.74–4.54). The same tendency was seen for advertising restrictions being associated with lower prevalence of weekly drinking. MPA correlated highly with availability policies and could therefore not be analysed in the mutually adjusted model. In the univariate model, MPA was associated with weekly drinking ($P = 0.007$) and drunkenness ($P = 0.02$).

MOR and ICC

The sex- and age-adjusted analyses showed that APCC accounted for a large part of the country variance in adolescent drunkenness. Adding APCC to the model reduced the ICC from 8.0 to 3.7% and reduced the MOR from 1.66 to 1.40 (Table 2). The full model further reduced the ICC to 3.2% among girls and 2.7% among boys (Table 3).

Availability policies accounted for most of the variation in weekly drinking and reduced the ICC from 10.5 to 6.5% and the MOR from 1.81 to 1.57 (Table 2). In the full model, the ICCs were reduced further to 6.3 and 5.0% for girls and boys, respectively (Table 4).

DISCUSSION

To our knowledge, this is the first multi-level study to examine the relationship between adolescent alcohol use, gender, adult drinking patterns and alcohol control policies across such a large number of countries. In this study of more than 140 000 adolescents in 37 countries we analysed how drunkenness and weekly drinking were associated with country-level policies and adult drinking characteristics.

The relationship between high adult per capita consumption and adolescent drunkenness was consistent across gender groups, and persisted after inclusion of other measures of adult drinking and alcohol control policies. This finding is supported by other studies, which found a positive relationship between adult and adolescent alcohol use across cities [15,16], states [39] and countries [14,21,22]. Fewer restrictions on minimum purchasing age and a risky drinking pattern in the adult population were also associated with higher risk of drunkenness in the univariate analyses. These associations persisted in the full model and were evident among boys and girls.

Fewer restrictions on the overall alcohol control policy, minimum purchasing age and availability were associated significantly with weekly drinking in the sex- and age-adjusted models. In the full model, weekly drinking was associated with fewer restrictions on availability and advertising policies. The finding that more comprehensive alcohol control policies may reduce the frequency of adolescent alcohol use corresponds with other studies [14,21,28,39].

The adult drinking measures were more often associated with drunkenness, while the alcohol control policies were associated to a greater extent with weekly drinking. These findings suggest differential mechanisms of influence for patterns of drunkenness and

frequency of drinking. Drunkenness appears to be related more strongly to cultural norms, whereas weekly drinking is related more strongly to alcohol control policies. This is in accordance with another study, which found that stronger policy measures were associated with lower prevalence of weekly drinking but not with drunkenness [14].

Overall, we found few gender differences. Drunkenness among girls but not boys was related significantly to low prevalence of abstainers. In the univariate analyses, having no age limit was associated significantly with drunkenness among boys, but not among girls. A plausible explanation is that girls are more exposed to social influences than boys, who are more likely to use commercial sources to obtain alcohol [51]. This suggests that alcohol control policies may be effective in relation to boys' alcohol use, while social norms might have a greater impact on girls' alcohol use. Another explanation could be gender differences in drinking norms [52,53], e.g. that alcohol use is more normative for boys than girls [8,41]. Consequently, girls may be more affected by the 'normality' of drinking in a given country, which may compel them to drink less in conformity with the country's alcohol culture [22,52]. More studies are needed to address these gender issues in detail.

The strengths of this study are its international scope, the use of multi-level models, inclusion of comprehensive measures of adult alcohol use and alcohol control policies, and the large study population. The standardized measures and methods used in the HBSC study provide a unique opportunity to examine cross-national differences and similarities in adolescent alcohol use in a large number of countries. Further, the study included two outcome measures, drunkenness and weekly drinking, which allowed us to analyse differences and similarities between these two outcome measures and country-level predictors.

Limitations include the cross-sectional design where causal relationship between adolescent alcohol use and country-level variables cannot be inferred. Secondly, important information is missing, such as country differences in the enforcement of alcohol control policies [24]. Thirdly, the validity of the country-level measures may vary across countries due to differences in data quality. Some variables may not reflect reality in 2009/10, where adolescent alcohol use was measured, thereby diminishing the explanatory power of these variables. As an example, per capita alcohol consumption was measured in 2003/05. Nevertheless, as changes in drinking culture occur slowly this is deemed to be of minor importance. Fourthly, the country level may not be adequate in relation to adolescents' alcohol use. The convergence in adolescent drunkenness between countries [41] suggests that youth are influenced more by global trends than by country-level factors. Fifthly, there is a possibility of selection bias from non-participating students who may show higher rates of alcohol use than those being at school [54]. This could lead to an underestimation of alcohol use in countries with low response rates. However, we do not consider this to be a major concern, as the low participation rates were a result of non-participation among schools (not among students) and because high prevalences of drunkenness were found in countries with low response rates. For example, Denmark and England had some of the lowest response rates, but some of the highest drunkenness prevalences. Most of the schools declining participation did so because of reasons not related to alcohol use. Lastly, cross-national differences in perception of drunkenness might have influenced our findings [9,55].

Information bias could occur if students in countries with low levels of per capita consumption systematically under- or over-estimated their level of drunkenness compared to students in countries with high levels of per capita consumption. However, anonymous surveys usually provide fairly accurate information about drunkenness [56]. Although the study provides valuable information on individual and country-level determinants of adolescent alcohol use, we cannot reflect the complexity in this study. Additional research is needed to understand more clearly the mechanisms through which country-level factors affect adolescents' alcohol use. As an example, alcohol policies might be a response to adult drinking patterns, or adult drinking patterns may influence alcohol control policies. This issue could be addressed with time-series data in future studies. Further, as all participating countries are located in Europe or North America, much remains to be learned about the nature of adult drinking patterns and alcohol control policies in countries in the rest of the world.

CONCLUSION

Adolescents' alcohol use reflects national drinking patterns and policies in their country. Weekly drinking was associated significantly with national alcohol control policies, while drunkenness was associated significantly with adult drinking patterns. This finding holds considerable importance from a public health perspective. Making alcohol less available and banning alcohol advertising may be effective strategies to reduce frequent drinking, whereas changed norms and drinking patterns in the adult population may help to reduce the prevalence of drunkenness.

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APPENDIX

Table A1

Odds ratio (OR) (95% confidence interval (CI) for drunkenness among girls and boys by adult drinking and alcohol control policies: multi-level logistic regression adjusted for age.

		<u>Girls</u>		<u>Boys</u>	
Fixed effects		OR (95% CI) P-value		OR (95% CI) P-value	
Adult drinking pattern					
Abstainers ^a		0.74 (0.61–0.90)	0.003	0.91 (0.74–1.12)	0.36
Per capita, total	Low	1.00 (ref.)	<0.001	1.00 (ref.)	<0.001
	Medium	2.14 (1.46–3.15)		1.87 (1.33–2.62)	
	High	3.25 (2.08–5.07)		3.54 (2.40–5.24)	
Male binge (%)	Low	1.00 (ref.)	0.02	1.00 (ref.)	0.08
	Medium	1.94 (1.13–3.33)		1.56 (0.82–3.01)	
	High	1.94 (1.21–3.12)		1.91 (1.08–3.40)	
Alcohol control policies					
Minimum purchasing age	20–21 years	1.00 (ref.)	0.07	1.00 (ref.)	0.01
	18 years	2.09 (1.06–4.12)		2.70 (1.44–5.03)	
	16 years	1.75 (0.83–3.69)		2.08 (1.07–4.03)	
	No age limit	1.48 (0.63–3.49)		2.54 (1.19–5.43)	
Availability policies	Strong	1.00 (ref.)	0.04	1.00 (ref.)	0.01
	Medium	1.21 (0.76–1.94)		1.57 (1.05–2.34)	
	Weak	1.78 (1.12–2.83)		2.02 (1.36–3.00)	
Advertising restrictions	Strong	1.00 (ref.)	0.04	1.00 (ref.)	0.11
	Medium	1.12 (0.69–1.80)		1.16 (0.73–1.82)	
	Weak	1.70 (1.09–2.65)		1.55 (1.01–2.37)	

Significant *P* values ($P < 0.05$) are marked in bold.

^a Assessed as a 10% increase in percentage of abstainers.

Table A2

Odds ratio (OR) (95% confidence interval (CI)] for weekly drinking among girls and boys by alcohol control policies: multi-level logistic regression adjusted for age.

		<u>Girls</u>		<u>Boys</u>	
<u>Fixed effects</u>		<u>OR (95% CI) P-value</u>		<u>OR (95% CI) P-value</u>	
Alcohol control policies					
Minimum purchasing age	20–21 years	1.00 (ref.)	0.04	1.00 (ref.)	0.01
	18 years	2.72 (1.33–5.54)		2.91 (1.39–6.06)	
	16 years	2.31 (1.07–4.99)		2.72 (1.23–6.02)	
	No age limit	3.17 (1.31–7.65)		4.63 (1.87–11.48)	
Availability policies	Strong	1.00 (ref.)	0.004	1.00 (ref.)	<0.001
	Medium	2.25 (1.33–3.82)		2.72 (1.77–4.20)	
	Weak	2.49 (1.46–4.27)		3.45 (2.22–5.34)	
Alcohol Control Policy Index	Strong	1.00 (ref.)	0.05	1.00 (ref.)	0.03
	Medium	1.92 (1.10–3.37)		1.83 (1.05–3.21)	
	Weak	1.74 (1.00–3.01)		2.10 (1.21–3.02)	
Advertising restrictions	Strong	1.00 (ref.)	0.04	1.00 (ref.)	0.10
	Medium	1.26 (0.76–2.27)		1.40 (0.75–2.60)	
	Weak	2.00 (1.15–3.48)		1.89 (1.06–3.38)	

Significant *P* values ($P < 0.05$) are marked in bold.

Figure 1.

Odds ratio for weekly drinking by the combined variable of gender and availability policy (reference value: girls in countries with strong alcohol control policies)

Table 1

Description of individual-level data and country characteristics (% , or other if indicated).

Region	n	Mean age, years	Boys, %	13-year-olds			Abstainers, %	Pattern of drinking score ^d	Per capita total ^b	Per capita drinkers ^c	Binge male % ^d	Minimum purchasing age, years ^e	Availability ^f	Alcohol control policy index ^f	Advertising ^f
				Drunk %	Weekly %	Drunk %									
Armenia	1916	14.4	46.4	30.4	13.4	39.7	17.7	18.8	2	11.4	18.3	–	0	–	–
Austria	3538	14.4	48.1	14.4	6.0	51.9	32.7	6.7	1	13.2	15.7	–	16	23	0
Belgium	5386	14.4	50.3	15.8	6.0	42.9	24.1	8.0	1	10.8	12.8	–	16	42	1
Canada	842	14.4	48.6	19.4	4.1	47.7	14.6	8.3	2	9.8	12.6	12.6	18	50	0
Croatia	4367	14.5	48.2	27.2	14.0	56.1	34.7	21.5	3	15.1	26.3	10.2	18	–	–
Czech	2969	14.5	47.6	33.0	19.1	62.7	38.5	4.6	3	16.5	19.5	30.7	18	35	0
Denmark	2467	14.6	47.0	23.6	8.3	67.9	21.4	0.8	2	13.4	14.4	13.1	16	33	1
England ^h	2301	14.5	41.9	24.4	8.5	49.1	21.6	12.1	3	13.4	15.6	–	18	36	0
Estonia	2805	14.8	48.1	27.5	8.1	62.5	16.6	10.5	3	15.6	22.0	15.7	18	–	–
Finland	3777	14.7	47.9	15.7	3.3	49.9	7.6	6.9	3	12.5	14.2	15.0	18	54	3
France	3970	14.4	49.5	13.6	7.9	35.8	18.7	2.6	1	13.7	14.9	8.0	18	27	18
Germany	3265	14.4	47.4	15.9	4.1	45.0	20.9	1.7	1	12.8	13.4	13.1	16	22	0
Greece	3257	14.7	49.7	17.4	13.2	42.0	38.6	13.9	1	10.8	15.0	–	0	36	0
Hungary	3302	14.5	46.8	25.1	7.8	57.1	25.3	6.5	2	16.3	20.0	18.0	18	58	0
Iceland	7380	14.5	50.5	5.6	1.9	26.6	6.2	9.0	3	6.3	7.7	11.3	20	64	3
Ireland	3562	14.4	56.0	14.5	4.6	42.1	12.6	20.5	3	14.4	19.3	43.4	18	41	0
Israel	2580	14.7	43.4	7.6	39.0	25.3	43.6	40.5	2	2.9	5.5	–	18	–	–
Italy	3219	14.4	49.7	12.4	12.3	31.9	32.4	12.6	1	10.7	13.0	11.1	0	34	3
Latvia	2761	14.6	48.2	37.2	8.2	67.8	23.1	9.8	3	12.5	16.5	20.0	18	–	–
Lithuania	3509	14.7	51.7	41.9	7.5	74.4	21.0	10.5	3	15.0	10.1	–	18	–	–
Luxembourg	2978	14.4	50.0	11.9	5.5	34.3	20.3	10.4	1	13.0	–	–	0	14	0
Macedonia	2816	14.6	50.7	9.1	3.6	31.1	17.9	40.5	3	8.5	–	–	18	–	–
Netherlands	3032	14.4	50.3	6.3	4.3	30.5	22.5	11.4	1	10.1	13.8	16.1	16	34	1
Norway	2634	14.5	50.5	7.4	4.2	37.8	10.0	3.2	3	7.8	8.7	2.7	18	67	–
Poland	2844	14.7	48.2	23.5	6.4	47.6	13.8	13.9	3	13.3	17.9	–	18	67	3
Portugal	2848	14.5	45.8	17.3	2.3	34.3	8.3	25.3	1	14.6	27.5	–	16	27	1
Romania	3673	14.2	49.1	30.6	16.8	53.3	23.8	12.8	3	15.3	24.5	–	18	–	–

Region	n	Mean age, years	13-year-olds				15-year-olds		Abstainers, %	Pattern of drinking score ^d	Per capita total ^b	Per capita drinkers ^c	Binge male % ^d	Minimum purchasing age, years ^e	Availability ^f	Alcohol control policy index ^f	Advertising ^f
			Boys, %	Drunk %	Weekly %	Weekly %	Drunk %	Weekly %									
Russia	2956	14.6	49.5	23.2	7.9	40.7	57.1	11.0	19.7	3	15.7	26.7	15.7	18	–	–	–
Scotland ^h	465	14.6	49.2	28.5	9.3	57.1	27.3	27.3	12.4	3	13.4	15.6	–	18	14	36	0
Slovakia	3851	14.4	48.9	26.8	12.0	53.2	21.8	21.8	7.3	3	13.3	17.3	15.0	18	4	57	1
Slovenia	3625	14.6	50.1	25.1	7.5	59.2	26.7	26.7	6.3	3	15.2	17.9	–	18	–	–	–
Spain	3777	14.5	48.4	17.3	6.0	49.5	22.6	22.6	17.1	1	11.6	21.1	–	16	11	41	3
Sweden	4358	14.4	49.8	7.5	3.5	36.6	10.0	10.0	8.1	3	10.3	12.5	2.3	20	20	64	3
Switzerland	4759	14.4	50.6	14.1	6.5	39.2	19.3	19.3	14.0	1	10.9	13.4	4.4	16	5	22	3
Ukraine	3731	14.7	47.1	29.9	17.4	55.4	36.3	36.3	22.7	3	15.6	27.9	21.2	0	–	–	–
US	4250	14.3	52.3	10.1	4.5	27.8	9.8	9.8	17.5	2	9.4	14.4	–	21	23	43	1
Wales ^h	3523	14.6	51.2	34.5	13.8	64.1	32.1	32.1	12.1	3	13.4	15.6	–	18	14	36	0
Mean (SD)		14.5 (1.1)	49.1 (0.0)	18.3 (0.4)	7.8 (0.3)	46.5 (0.5)	21.1 (0.4)	21.1 (0.4)	12.8 (8.9)	2.4 (1.1)	12.4 (2.9)	22.3 (7.8)	15.0 (9.4)	15.8 (5.7)	9.4 (7.2)	40.9 (14.8)	1.2 (1.3)

^aPatterns of drinking score ranging from 1–3, with 3 indicating the most harmful drinking pattern.

^bBased on recorded alcohol consumption and estimations of unrecorded alcohol measured in litres of pure alcohol consumed by the adult population (aged 15 years or more).

^cAlcohol per capita consumption among drinkers measured as pure alcohol consumed by the drinking population in litres.

^dDefined as having at least 60 g or more of pure alcohol on one occasion during the past 7 days.

^eMinimum purchasing age for any type of alcohol.

^fAlcohol Control Policy Index taken from Brand *et al.* 2007 [36].

^gFrance was the only country with a score of 2 and was therefore grouped with countries scoring 1.

^hThe UK average was applied to Scotland, England and Wales, as regional data on adult drinking patterns were not available for the time-period—no data available.

Table 2

Odds ratio (OR) (95% confidence interval (CI) for adolescent drunkenness and weekly drinking by adult drinking and alcohol control policies: multi-level logistic regression adjusted for age and gender.

Fixed effects	Countries	Drunkenness		Weekly drinking	
		Model 1 (age and gender)		Model 1 (age and gender)	
		OR (95% CI) P-value	MOR/ICC	OR (95% CI) P-value	MOR/ICC
Adult drinking pattern					
Total, abstainers (%)	Low	10 1.00 (ref.)	0.29	1.63/7.4	1.00 (ref.) 0.99 1.84/11.1
	Medium	14 0.89 (0.58–1.35)*			0.99 (0.55–1.78)
	High	13 0.68 (0.41–1.13)*			0.96 (0.58–1.59)
Pattern of drinking score	Low risk	17 1.00 (ref.)	0.01	1.60/6.9	1.00 (ref.) 0.62 1.81/10.7
	High risk	20 1.57 (1.14–2.18)			0.86 (0.57–1.31)
Per capita, total	Low	11 1.00 (ref.)	<0.001	1.40/3.7	1.00 (ref.) 0.13 1.78/10.0
	Medium	14 1.98 (1.42–2.76)*			1.32 (0.78–2.24)
	High	12 3.35 (2.28–4.93)*			1.86 (1.01–3.42)
Per capita, drinkers	Low	12 1.00 (ref.)	<0.001	1.50/5.1	1.00 (ref.) 0.84 1.86/11.5
	Medium	12 2.01 (1.44–2.81)			1.10 (0.65–1.89)
	High	11 2.64 (1.79–3.87)			1.20 (0.64–2.22)
Male binge (%)	Low	7 1.00 (ref.)	0.04	1.57/6.3	1.00 (ref.) 0.52 1.86/11.6
	Medium	5 1.76 (0.99–3.15)*			0.97 (0.43–2.18)
	High	8 1.92 (1.15–3.20)*			1.40 (0.69–2.86)
Alcohol control policies					
Minimum purchasing age	20–21 years	3 1.00 (ref.)	0.02	1.61/7.0	1.00 (ref.) 0.01 1.69/8.4
	18 years	21 2.62 (1.43–4.80)*			2.83 (1.40–5.72)*
	16 years	8 1.90 (0.99–3.67)*			2.54 (1.19–5.44)*
	No age limit	5 1.93 (0.91–4.90)*			3.93 (1.66–9.28)*
Availability policies	Strong	7 1.00 (ref.)	0.01	1.46/4.6	1.00 (ref.) <0.001 1.57/6.5
	Medium	10 1.37 (0.89–2.10)*			2.50 (1.58–3.97)*
	Weak	10 1.90 (1.25–2.89)*			3.16 (1.95–5.13)*

Fixed effects	Countries	Drunkenness			Weekly drinking		
		Model 1 (age and gender)		MOR/ICC	Model 1 (age and gender)		MOR/ICC
		OR (95% CI)	P-value		OR (95% CI)	P-value	
Alcohol control policy index	Strong	9	1.00 (ref.)	0.69	1.56/6.3	1.00 (ref.)	0.03
	Medium	8	1.04 (0.64–1.68)			1.88 (1.09–3.28) *	
	Weak	10	1.20 (0.74–0.94)			1.93 (1.13–3.28) *	
Advertising restrictions	Strong	8	1.00 (ref.)	0.06	1.49/5.1	1.00 (ref.)	0.06
	Medium	8	1.14 (0.72–1.79) *			1.33 (0.73–2.40) *	
	Weak	11	1.61 (1.06–2.47) *			1.93 (1.11–3.36) *	
Random effects							
Country-level variation					1.66/8.0		1.81/10.5

Significant *P* values (*P* < 0.05) are marked in bold.

* Significant interaction on gender (for further information see Appendix).

MOR = median odds ratio; ICC = intraclass correlation.

Table 3

Odds ratio (OR) (95% confidence interval (CI) for drunkenness among boys and girls by adult drinking pattern and alcohol control policies, mutually adjusted (only significant associations are shown) ($n = 37$ countries).

Variable	Drunkenness			
	Girls (n = 71 319)		Boys (n = 68 778)	
	OR (CI)	P	OR (CI)	P
13-year-olds	1.00 (ref.)	<0.001	1.00 (ref.)	<0.001
15-year-olds	3.89 (3.73–4.00)		3.61 (3.46–3.76)	
Adult drinking pattern				
Abstainers ^a	0.79 (0.68–0.90)	0.001	–	
Per capita, total				
Low	1.00 (ref.)	<0.001	1.00 (ref.)	<0.001
Medium	2.00 (1.38–2.89)		2.04 (1.49–2.80)	
High	2.44 (1.57–3.80)		3.15 (2.13–4.64)	
Pattern of drinking score				
Low risk	1.00 (ref.)	0.01	1.00 (ref.)	0.002
Medium	1.76 (1.17–2.66)		1.76 (1.03–3.02)	
High risk	1.61 (1.18–2.18)		2.02 (1.33–3.05)	
Policies				
Minimum purchasing age				
20–21 years	1.00 (ref.)	0.03	1.00 (ref.)	0.01
18 years	1.67 (1.05–2.63)		1.99 (1.31–3.02)	
16 years	2.21 (1.16–4.18)		2.39 (1.33–4.29)	
No age limit	1.45 (0.76–2.78)		1.92 (1.08–3.43)	
Random				
MOR ^b /ICC ^b	1.72/9.0		1.69/8.6	
MOR ^c /ICC ^c	1.37/3.2		1.33/2.7	
Goodness-of-fit				
Dispersion parameter	0.99		1.00	
Number of iterations	9		3	

^a Assessed as a 10% increase in percentage of abstainers.

^b Age-adjusted.

^c Fully adjusted.

MOR = median odds ratio; ICC = intraclass correlation.

Table 4

Odds ratio (OR) (95% confidence interval (CI) for weekly drinking among boys and girls by adult drinking pattern and alcohol control policies, mutually adjusted (only significant associations are shown)($n = 27$ countries).

Variable	Weekly drinking			
	Girls (n = 53 148)		Boys (n = 51 528)	
	OR (CI)	P	OR (CI)	P
13-year-olds	1.00 (ref.)	<0.001	1.00 (ref.)	<0.001
15-year-olds	3.46 (3.20–3.74)		3.50 (3.27–3.74)	
Policies				
Availability				
Strong	1.00 (ref.)	0.02	1.00 (ref.)	<0.002
Medium	1.41 (1.07–1.86)		1.68 (1.32–2.13)	
Weak	2.00 (1.15–3.46)		2.82 (1.74–4.54)	
Advertising				
Strong	1.00 (ref.)	0.02	1.00 (ref.)	0.04
Medium	1.34 (1.05–1.71)		1.25 (1.01–1.55)	
Weak	1.79 (1.10–2.94)		1.56 (1.02–2.40)	
Random				
MOR ^a /ICC ^a	1.79/10.2		1.86/11.5	
MOR ^b /ICC ^b	1.56/6.3		1.49/5.0	
Goodness-of-fit				
Dispersion parameter	0.99		0.99	
Number of iterations	5		4	

^a Age-adjusted.

^b Fully adjusted.

MOR = median odds ratio; ICC = intraclass correlation.