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Liberal alcohol legislation: does it amplify the effects among Swiss men of person-related risk factors on heavy alcohol use?

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Abstract: AIM: To estimate the statistical interactions between alcohol policy strength and the person-related risk factors of sensation-seeking, antisocial personality disorder and attention-deficit/hyperactivity disorder related to heavy alcohol use. DESIGN: Cross-sectional survey. SETTING: Young Swiss men living within 21 jurisdictions across Switzerland. PARTICIPANTS: A total of 5701 Swiss men (mean age 20 years) participating in the Cohort Study on Substance Use Risk Factors (C-SURF). MEASUREMENTS: Outcome measures were alcohol use disorder (AUD) as defined in the DSM-5 and risky single-occasion drinking (RSOD). Independent variables were sensation-seeking, antisocial personality disorder (ASPD), attention-deficit/hyperactivity disorder (ADHD) and an index of alcohol policy strength. FINDINGS: Alcohol policy strength was protective against RSOD [odds ratio (OR) = 0.91 (0.84-0.99)], while sensation-seeking and ASPD were risk factors for both RSOD [OR = 1.90 (1.77-2.04); OR = 1.69 (1.44-1.97)] and AUD [OR = 1.58 (1.47-1.71); OR = 2.69 (2.30-3.14)] and ADHD was a risk factor for AUD [OR = 1.08 (1.06-1.10)]. Significant interactions between alcohol policy strength and sensation-seeking were identified for RSOD [OR = 1.06 (1.01-1.12)] and AUD [OR = 1.06 (1.01-1.12)], as well as between alcohol policy strength and ASPD for both RSOD [OR = 1.17 (1.03-1.31)] and AUD [OR = 1.15 (1.02-1.29)]. These interactions indicated that the protective effects of alcohol policy strength on RSOD and AUD were lost in men with high levels of sensation-seeking or an ASPD. No interactions were detected between alcohol policy strength and ADHD. CONCLUSION: Stronger alcohol legislation protects against heavy alcohol use in young Swiss men, but this protective effect is lost in individuals with high levels of sensation-seeking or having an antisocial personality disorder.

Liberal alcohol legislation: Does it amplify the effects of person-related risk factors on heavy alcohol use?

Running head:

Alcohol policy and person-related diathesis

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Abstract

Aim: To estimate the statistical interactions between alcohol policy strength and the person-related risk factors of sensation seeking, antisocial personality disorder, and attention-deficit/hyperactivity disorder related to heavy alcohol use.

Design: Cross-sectional survey.

Setting: Young Swiss men living within 21 jurisdictions across Switzerland.

Participants: 5,701 Swiss men (mean age 20.0 years) participating in the Cohort Study on Substance Use Risk Factors (C-SURF).

Measurements: Outcome measures were alcohol use disorder (AUD) as defined in the DSM-5 and risky single-occasion drinking (RSOD). Independent variables were sensation seeking, antisocial personality disorder (ASPD), attention-deficit/hyperactivity disorder (ADHD), and an index of alcohol policy strength.

Findings: Alcohol policy strength was protective against RSOD (OR=0.91 [0.84-0.99]), while sensation seeking and ASPD were risk factors for both RSOD (OR=1.90[1.77-2.04]; OR=1.69[1.44-1.97]) and AUD (OR=1.58[1.47-1.71]; OR=2.69[2.30-3.14]), and ADHD was a risk factor for AUD (OR=1.08[1.06-1.10]). Significant interactions between alcohol policy strength and sensation seeking were identified for RSOD (OR = 1.06 [1.01-1.12] and AUD (OR = 1.06[1.01-1.12]), as well as between alcohol policy strength and ASPD for both RSOD (OR = 1.17, [1.03-1.31]) and AUD (OR = 1.15[1.02-1.29]. These interactions indicated that the protective effects of alcohol policy strength on RSOD and AUD were lost in individuals with high levels of sensation seeking or an ASPD. No interactions were detected between alcohol policy strength and ADHD.

Conclusion: Stronger alcohol legislation protects against heavy alcohol use in young men, but this protective effect is lost in individuals high in sensation seeking or having an antisocial personality disorder.

Introduction

Alcohol use was rated as one of five leading risk factors for increased burden of disease in 2010, and has been causally implicated in the aetiology of dozens of acute and chronic disease states (1-5). Accordingly, policy makers worldwide have strived to regulate the availability of alcohol as a means of preventing harmful alcohol consumption. Studies have shown that implementing alcohol policies like increasing alcohol taxes and prices, increasing minimum legal drinking age, and limiting days of alcohol sales decrease alcohol consumption and/or alcohol-related harm (6-13). Furthermore, several recent studies have demonstrated that *alcohol policy strength*, defined as the number of alcohol policies implemented within a given jurisdiction, is negatively associated with different aspects of alcohol consumption in adolescents and adults (14-19).

However, besides well-established protective effects, there might be another route by which alcohol legislation impacts alcohol use that has not been examined in previous research (6-19). Because alcohol policies influence the visibility and availability of alcohol (7, 20-21), they might set a more versus less restrictive playground for *other* risk factors of heavy alcohol use. In particular, people with a high propensity for problematic use may more readily engage in such use if alcohol is highly visible and available. From a prevention perspective, if alcohol legislation is an effect modifier of person-related diatheses, this would indicate an important additional need for implementing stronger alcohol policies.

In the present study, we examined whether three person-related risk factors — sensation seeking, antisocial personality disorder (ASPD), and attention-deficit/hyperactivity disorder (ADHD) — exert a stronger relationship with heavy alcohol use in jurisdictions with comparably low alcohol policy strength. These risk factors present a diathesis towards heavy alcohol use and share a propensity for behavioural disinhibition and impulsivity that mediates

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part of the genetic risk for heavy alcohol use (22-25). *Sensation seeking* is a personality trait characterised by a propensity to seek out novel or thrilling stimulation at the expense of physical and social risks (25-26). It has been shown to be a risk factor for heavy alcohol use (23, 25-28). *ASPD* is characterised by a pervasive pattern of disregard for, and violation of, the rights of others and social norms that begins in early childhood or adolescence and continues into adulthood (29-30). It is strongly associated with heavy alcohol and drug use (29, 31-34). Finally, *ADHD* is characterised by symptoms of inattention and/or hyperactivity-impulsivity that start in childhood or adolescence and can continue into adulthood (35-37). It has been shown to be a risk factor for heavy alcohol use (36, 38-40). Thus, all these person-related risk factors lead to a diathesis for heavy alcohol use. If alcohol is also highly visible and available, the risk conveyed with these factors may increase disproportionally.

Our aim was to examine interactions between alcohol policy strength and person-related risk factors on *risky single occasion drinking* (RSOD) and *alcohol use disorder* (AUD). We studied a large sample of young men, because they are among those at highest risk for heavy alcohol use (4, 41) and hence should be a priority for prevention efforts. We hypothesized that a) alcohol policy strength has protective effects on RSOD and AUD; b) sensation seeking, ASPD, and ADHD are risk factors for RSOD and AUD, and c) an interaction exists between person-related risk factors and alcohol policy strength, in that the risk associated with person-related factors will be higher when alcohol policy strength is low. The study extends previous literature by a) assessing interactions between alcohol policy strength and person-related risk factors; and b) including AUD as a possible outcome of alcohol legislation (6-19).

Methods

Study design

The study utilised cross-sectional data from the baseline assessment of the 'Cohort Study on Substance Use Risk Factors' (C-SURF) in Switzerland. Switzerland is a federation of 26 cantons and well-known for liberal alcohol policies at the national level, while providing high legislative autonomy to its cantons (14, 42). As such, the study allowed us to examine the impacts of alcohol policy strength within one country with sufficient variability between regions.

The C-SURF study protocol was approved by the Ethics Committee for Clinical Research at Lausanne University Medical School (protocol number 15/07) and informed written consent was obtained from all participants. Participants were enrolled at army recruitment centres. The included recruitment centres covered 21 of 26 Swiss cantons, allowing us to enrol an approximately representative sample of young Swiss men. By enrolling participants via army recruitment centres, the study took advantage of the Swiss requirement for all ~19 year-old men to present to determine their eligibility for mandatory military service with no existing pre-selection to army conscription. Note that army centres were used for participant enrolment only; the study itself and the men's decision to participate were entirely independent of the army. For example, surveys were sent to participants' homes and data was not shared with the army. We used data drawn from the baseline assessment collected between September 2010 and March 2012.

Sample

Details on sampling and non-response bias were published by Studer et al. (43-44), indicating small bias between consenters and non-consenters. Of 7563 consenters (57.1%), a total of 5990 young men (79.2%) completed the baseline survey. Some missing answers for sensation seeking, ASPD, and ADHD were replaced by nearest-neighbour hot-deck imputation as outlined by Iacus and Porro (45), using R software (46) and the "RRP" library (45). For each

of these variables, imputation was performed when participants failed to answer no more than two questions. After this imputation process, 289 participants (4.8%) were excluded due to additional missing data (230 with missing data in the predictor variables, 5 in the predictor and the outcome variables, and 54 in the outcome variables), leading to an analytic sample of 5701. A total of 98 participants within this analytic sample (1.7%) had missing values replaced for sensation seeking, ASPD, or ADHD, with 94 having one, three having two, and one having six values replaced.

Outcome measures

Risky single occasion drinking (RSOD): Pictures of standard drinks each containing 10-12g pure alcohol were provided for different beverage types, and participants were asked how frequently they had consumed six or more standard drinks on a single occasion over the preceding 12 months. Five answer options were provided, ranging from "never" to "daily or almost daily". A binary RSOD-variable was defined as having such an episode at least once a month versus not (47).

Alcohol use disorder (AUD): Criteria for AUD were asked as per Knight et al (48), including the additional criteria of "craving". These criteria correspond to the symptoms of AUD as defined in DSM-5 and were assessed for the last 12 months, with two answer options for each criterion (yes/no). Participants were diagnosed with AUD if they reported at least two criteria (49), and a binary variable was created ("no AUD" vs. "AUD").

Explanatory variables

Cantonal alcohol policy strength: An overview checklist regarding eight different types of alcohol policy implemented by cantons in 2011was obtained from the Swiss Federal Office of Public Health (Table 1). These included 1) restrictions on *where* alcohol can be sold; 2)

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restrictions on *when* alcohol can be sold; 3) restrictions on alcohol advertisements; 4) so called 'syrup regulation' stating that on-premise outlets must provide at least one non-alcoholic beverage sold cheaper than the cheapest alcoholic drink; 5) a special turnover tax for on- and off-premise alcohol sellers; 6) special protection measures for adolescents[1]; 7) probes of purchases by underage persons to enforce underage drinking laws; and 8) prohibiting the dissemination of alcohol to underage persons by persons with legal access to alcohol. An index of alcohol policy strength was calculated by summing the number of policies implemented within each canton. Such summary indices were shown to be valid measures in previous studies (17-18).

Sensation seeking: Sensation seeking was assessed via the "Brief Sensation Seeking Scale" (BSSS), which has established validity and reliability (26). The BSSS consists of eight items with answer options ranging from 1 ("disagree") to 5 ("agree"). The eight items were averaged to form the scale (range: 1-5, Cronbach's α: 0.81).

Antisocial personality disorder (ASPD): The symptoms of ASPD were assessed via the Mini International Neuropsychiatric Interview (MINI plus) (50). Six answer options ranging from "never" to "20 times or more" were provided and were dichotomised to indicate the absence vs. presence of each symptom. In accordance with the MINI plus, ASPD was defined as the presence of at least two symptoms before the age of 15 and at least there afterwards, and a binary variable ("no ASPD" vs. "ASPD") was created.

Adult Attention-deficit/Hyperactivity Disorder (ADHD): Adult ADHD was assessed via the Adult ADHD Self-Report Scale Screener (ASRS-v1.1), developed by the World Health

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[1] These measures included particularly restricting the serving of adolescents at on-premise outlets in the evening and at night and increasing the national minimum legal drinking age.

Organization (51-52). This instrument contains six questions corresponding to the DSM-IV diagnostic criteria for ADHD. Symptoms were assessed for the past 12 months. Answers were assessed on a 5-point scale ranging from "never" (0) to "very often" (4). Responses were then summed to generate a summary score ranging from 0 to 24. The summary score was preferred to a binary diagnosis because it has been found that the persistence of ADHD into adulthood often takes the form of partial remission; i.e. persistence is *symptomatic* (maintaining partial diagnostic status with impairment) rather than *syndromatic* (maintaining full diagnostic status) (35, 37). Since we examined an adult sample, using the summary score was deemed more appropriate.

Control variables

We included depression (22, 35, 53) and socio-demographic variables as control variables. Depression was assessed via the Major Depressive Inventory WHO-MDI(54) and included as a dichotomized variable (no depression/at least mild depression). Socio-demographic variables included age (continuous), highest achieved education (obligatory school, secondary vocational education, secondary higher school education, tertiary education), linguistic region (French speaking, German speaking), and urban/rural status (city, agglomeration, rural) as defined by the Swiss Federal Statistical Office.

Statistical analyses

We analyzed the binary outcomes "RSOD" and "AUD" using both standard and multilevel logistic regression models. In models 1a – 1d, we examined for each explanatory variable whether it had any relationship with the outcomes. We did so by using standard logistic regression analysis assessing the unadjusted associations of each explanatory variable (alcohol policy strength, sensation seeking, ASPD, ADHD) with each outcome. In model 2, we examined whether the explanatory variables had relationships with the outcomes

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independent of each other and beyond the control variables. We did so by assessing the adjusted main effects of the explanatory variables, applying a two-level random intercept model with participants (level 1) nested within cantons (level 2). This model included the explanatory variables (alcohol policy strength, sensation seeking, ASPD, ADHD), the control variables, and a random-intercept for cantons. Finally in models 3a – 3c, we assessed for statistical interactions between alcohol policy strength and person-related risk factors, applying the two-level random intercept model outlined above. In model 3a, the interaction between alcohol policy strength and sensation seeking was assessed; in model 3b, between alcohol policy strength and ASPD; and in 3c, between alcohol policy strength and ADHD. Each of the models 3a-3c was adjusted for the remaining person-related risk factors (e.g., model 3a for ASPD and ADHD) and control variables and included the random-intercept for cantons.

A random-intercept multi-level model was used for models 2 and 3a-c in order a) to control for unobserved heterogeneity among cantons and b) because participants were clustered within cantons. Such clustering can lead to a violation of the assumption of independent observations made in ordinary regression analysis. If not taken into account, the standard errors of the regression coefficients will be too small, leading to spuriously significant results (55).

For *descriptive* analyses, age, alcohol policy strength, sensation seeking, and ADHD-score were dichotomized around their medians. Alcohol policy strength was dichotomized around the median of the cantons, while the remaining variables were dichotomized around the medians of participants. For *regression* analyses, these variables were entered as continuous variables in the models and centred around their means (55). For centring alcohol policy

strength, the canton mean was used, while participant means were used for the remaining variables.

Odds ratios (OR) with 95% confidence intervals and p-values for the null hypothesis OR=1.00 were computed for each explanatory variable. To illustrate interactions, the regression models were used to calculate the predicted probabilities of RSOD and AUD across different combinations of the person-related risk factors and alcohol policy strengths, while fixing all other variables at typical values (56). Continuous variables were fixed at their means and categorical variables at their proportional distributions observed in the sample (56). All statistical analyses were performed using R software (46), using the "glm"-function in the base package to conduct standard logistic regression, the "glmer"-function in the "lme4"-library for conducting multilevel analyses (57) and the "Effect"-function in the "effects"-library (56) for the illustration of the interaction effects.

Results

Baseline characteristics and main effects

Baseline characteristics and outcomes are displayed in Table 2. The mean age of the 5701 participants was 20.0 years (standard deviation: 1.2, range: 17.9 – 28.5). All but one subject were above the national legal drinking age of 18. Roughly 49% had completed obligatory school and 49.7% some form of secondary education. The cantons had an average number of 3.5 (standard deviation: 1.6, range: 0.0 – 6.0) alcohol policies implemented.

Insert Table 2 here

In unadjusted models, there was statistical evidence that alcohol policy strength was protective and reduced the odds of RSOD and AUD, and that sensation seeking, ASPD, and

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ADHD were risk factors (Table 3). In model 2 (Table 3), alcohol policy strength remained a protective factor against RSOD; ASPD and sensation seeking remained risk factors for both outcomes; and ADHD remained a risk factor for AUD.

Insert Table 3 here

Interactions

Sensation seeking and ASPD interacted with alcohol policy strength for both RSOD and AUD, whereas no statistical interactions were evident for ADHD (table 3). Table 4 summarizes statistical interactions by showing the probabilities of RSOD and AUD predicted by the regression models across different combinations of alcohol policy strength and person-related risk factors. While we had hypothesized that the risk associated with sensation seeking and ASPD would be higher when alcohol policy strength was lower, results were more compatible with the protective effects of alcohol policy strength being eliminated by high sensation seeking and the presence of an ASPD. For example, in low sensation seekers, the probability of RSOD decreased from 0.38 in cantons with low to 0.14 in cantons with high policy strength. However, in high sensation seekers, it remained comparably high or even slightly increased from 0.73 to 0.76. Similar patterns were detected for the remaining interactions.

Insert Table 4 here

Complementary analysis

When analysing AUD, there was no statistical evidence for a protective relationship of alcohol policy strength with AUD in models 2 and 3c (Table 3). However, the interactions identified above indicate that sensation seeking and ASPD acted as effect modifiers that

clouded some of the relationship between alcohol policy strength and AUD. We therefore examined whether models 2 and 3c yield statistical evidence of associations between alcohol policy strength and AUD with the interaction between alcohol policy strength and either ASPD or sensation seeking included (models 4a-b). As can be seen in Table 5, this hypothesis was supported.

Insert Table 5 here

Discussion

The present study examined the hypotheses that a) strong alcohol policies protect against heavy alcohol use; b) sensation seeking, ASPD, and ADHD are risk factors; and c) the risks associated with these person-related factors are higher when alcohol policy strength is low. Our results support the protective effects of alcohol policy strength on RSOD and AUD, the risks associated with sensation seeking and ASPD for both outcomes, and the risk associated with ADHD for AUD. Unexpectedly, however, interaction effects were in the opposite direction: protective effects of alcohol policy strength disappeared in young men with high sensation seeking and an ASPD. No evidence of any interaction was revealed between ADHD and alcohol policy strength.

Our results are consistent with previous studies indicating that alcohol use is lower in jurisdictions with stronger alcohol legislation (14-19). These studies involved both adolescents and adults from Western countries. Our results extend this finding to young Swiss men around 20 years old. In addition, we discovered evidence for interactions between alcohol policy strength and both sensation seeking and ASPD. Although we are not aware of any other study examining such interactions, there is a conceptual link to previous studies. Several earlier studies assessed both moderate and heavier forms of drinking and alcohol

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policy strength was consistently negatively associated with moderate drinking behaviours, but not with heavier forms of drinking (15-16, 19). Our results offer one potential explanation for these prior results. Presumably, the prevalence of persons high in sensation seeking or antisocial behaviour is greater among those exhibiting heavier drinking behaviours; hence, alcohol policy strength is likely to be less effective at reducing such drinking behaviours.

Such heterogeneity in the protective effect of alcohol policies was also revealed in a simulation study by Meier et al. using population-based data from the United Kingdom (58). The investigators found that different variants of pricing policy exerted different effects as a function of age, consumption pattern, and gender . Particularly, considering males and young hazardous male drinkers, alcohol consumption was reduced when policies increased on-premise but not off-premise prices, whereas female drinkers were more affected by increases in off-premise prices. Our results indicate that among young men, additional heterogeneity is introduced by sensation seeking and ASPD, thereby echoing Meier et al.'s conclusion that alcohol policy making needs to account for population heterogeneity. Sensation seeking and ASPD likely contribute to such heterogeneity and, hence, should be included as variables of interest in future studies.

Our findings also imply that studies that consider only the overall effect of alcohol legislation on heavy drinking will tend to underestimate its protective effect in some subgroups (people low in sensation seeking and antisocial behaviours) but overestimate it in other subgroups that are actually unaffected by alcohol legislation (people high in sensation seeking and antisocial behaviour). From a prevention perspective, our results imply that implementing alcohol control policies is protective, but additional measures are needed for people with a high diathesis for heavy alcohol use. Short interventions for heavy and risky drinkers, as well as interventions tailor-made to the cognitive, emotional, and motivational processes related to

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sensation seeking and other person-related risk factors have already been identified as promising approaches (59-61). In addition, the protective effect of alcohol policy strength was more robust in our subjects with RSOD than with AUD. A likely explanation is that the AUD-group contained more "extreme" individuals who were less influenced by alcohol legislation than the RSOD-group (58, 62), in particular chronic heavy drinkers, physiologically-dependent drinkers, and people with an ASPD. For policy makers, this implies that alcohol legislation might be more effective at tackling drinking than AUD, a distinction not revealed in previous studies.

Finally, our results agree with prior studies indicating that sensation seeking and ASPD are strong risk factors for heavy alcohol use (22-23, 25-29, 31-34). The interactions we discovered suggest that one mechanism by which these factors lead to heavy alcohol use is by making people less sensitive to otherwise-protective factors. In contrast, ADHD was related to AUD, but not to RSOD, and exhibited no interactions (even when not controlling for sensation seeking and ASPD; data not shown). The lack of any interactions implies that not all person-related diathesis factors interact with alcohol policy strength. Further research is needed to clarify this finding.

Study limitations

First, our study was cross-sectional; hence, causal inferences should not be made. Note, however, that this does not place the interactional effects themselves into question, and previous studies suggest causal effects of both alcohol policy strength and person-related risk factors (6-13, 28, 33, 38). Second, our results were based upon a sample of young men only. This might be important for the effect modifications found, as ASPD and sensation seeking are more prevalent in young men than in women or older adults (32, 63-66). Future studies

should examine the generalization of our results to other subpopulations. Third, study inclusion was based upon informed consent, meaning that selection bias might have been present. Note, however, that there was no indication of substantial bias in previous studies involving the C-SURF sample (43-44). Fourth, there might be residual confounding at the canton level by factors like alcohol outlet density or drinking norms that were not included in our regression models. Note, however, that including the random intercept for cantons accounted for unobserved differences between the cantons. Finally, most of our study variables relided on self-reports, potentially introducing biases like recollection bias or social desirability. Note, however, that our explanatory variables were based upon validated instruments, and previously-published studies assessing self-report measures of alcohol consumption have shown them to be valid (67-68).

Conclusion

Stronger alcohol legislation is protective against heavy drinking and AUD in young men, but this protection is lost in individuals high in sensation seeking or with an antisocial personality disorder.

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Table 1 Overview of types of alcohol policy and the number and percentage of cantons endorsing them

Type of alcohol policy	Number and percent of cantons endorsing the policy	
	n	*%*
Prohibition of the dissemination of alcohol to underage persons by persons with legal access to alcohol	2	9.5
Special protection measures for adolescents [a]	3	14.3
Restrictions on *when* alcohol can be sold	4	19.0
Special turnover tax for on- and off-premise alcohol sellers	6	28.6
Restrictions on alcohol advertisements	10	47.6
Restrictions on *where* alcohol can be sold	15	71.4
Probes of purchases by underage persons to enforce underage drinking laws	15	71.4
Syrup regulation [b]	19	90.5

Note: total number of cantons is 21.

[a] These measures included particularly restricting the serving of adolescents at on-premise outlets in the evening and at night and increasing the national minimum legal drinking age.

[b] This regulation states that on-premise outlets must provide at least one non-alcoholic beverage sold cheaper than the cheapest alcoholic drink

Table 2: Baseline characteristics of study participants

	Mean±SD (range)	n (%)	RSOD (prevalence in %)	χ^2 (df) [b]	p-value	AUD (prevalence in %)	χ^2 (df) [b]	p-value
Total		5701	45.9			31.6		
Age [a]	20.0 ±1.2 (17.9-28.5)							
Below median of participants		2857 (50.1)	48.7	18.3 (1)	<0.0001	32.7	3.4 (1)	0.064
Above median of participants		2844 (49.9)	43.1			30.4		
Education	-							
Obligatory school		2775 (48.7)	46.3	2.1 (3)	0.55	31.9	1.9 (3)	0.59
Secondary vocational		1806 (31.7)	45.8			30.4		
Secondary higher school		1027 (18.0)	45.7			32.7		
Tertiary		93 (1.6)	38.7			31.2		
Linguistic region	-							
German-speaking		2578 (45.2)	47.7	6.2 (1)	0.013	32.9	4.4 (1)	0.037
French-speaking		3123(54.8)	44.4			30.4		
Rural/urban status	-							
City		1220 (21.4)	41.5	27.6 (2)	<0.0001	31.2	11.2 (2)	0.004
Agglomeration		2620 (46.0)	44.7			29.7		
Rural		1861 (32.6)	50.6			34.4		
Depression	-							
No		5358 (94.0)	46.0	0.2 (1)	0.62	30.7	31.4 (1)	<0.0001
At least mild		343 (6.0)	44.6			45.2		
Alcohol policy strength [a]	3.5 ±1.6 (0.0-6.0)							
Below median of cantons		1582 (27.7)	51.8	30.3 (1)	<0.0001	34.5	8.5 (1)	0.004
Above median of cantons		4119 (72.3)	43.7			30.4		
Sensation seeking [a]	3.1 ±0.9 (1.0-5.0)							
Below median of participants		3047 (53.5)	35.5	284.7 (1)	<0.0001	23.1	216.4 (1)	<0.0001
Above median of participants		2654 (46.5)	57.8			41.3		
Anti-social personality disorder	-							
No		4764 (83.6)	42.6	131.5 (1)	<0.0001	26.4	355.9 (1)	<0.0001
Yes		937 (16.4)	63.0			57.7		
ADHD score [a]	5.6 ±4.3 (0.0-24.0)							
Below median of participants		2875 (50.4)	41.8	39.2 (1)	<0.0001	23.1	190.6 (1)	<0.0001
Above median of participants		2826 (49.6)	50.1			40.1		

Note. SD: Standard Deviation; RSOD: Risky Single Occasion Drinking at least once a month; AUD: Alcohol Use Disorder (DSM-5); ADHD: Attention-Deficit/Hyperactivity Disorder.

[a] dichotomized around the median for descriptive analyses

[b] Pearson Chi-square test statistic for contingency tables with degrees of freedom in brackets

Table 3: Results of standard and multilevel logistic regressions predicting risky single occasion drinking and alcohol use disorder

	RSOD				AUD			
	b	OR	95% CI	p-value	*b*	OR	95% CI	p-value
Models 1a-d: unadjusted								
a) Alcohol policy strength	-0.12	0.89	0.85-0.92	<0.0001	-0.07	0.93	0.89-0.97	0.001
b) Sensation seeking	0.69	1.99	1.86-2.13	<0.0001	0.62	1.87	1.74-2.00	<0.0001
c) ASPD	0.83	2.30	1.99-2.65	<0.0001	1.34	3.81	3.30-4.40	<0.0001
d) ADHD score	0.04	1.04	1.03-1.06	<0.0001	0.11	1.11	1.10-1.13	<0.0001
Model 2: adjusted [a]								
Alcohol policy strength	-0.09	0.91	0.84-0.99	0.024	-0.06	0.94	0.88-1.00	0.066
Sensation seeking	0.64	1.90	1.77-2.04	<0.0001	0.46	1.58	1.47-1.71	<0.0001
ASPD	0.52	1.69	1.44-1.97	<0.0001	0.99	2.69	2.30-3.14	<0.0001
ADHD score	0.01	1.01	1.00 -1.03	0.058	0.08	1.08	1.06-1.10	<0.0001
Model 3a: interaction effect alcohol policy strength x sensation seeking [b]								
Alcohol policy strength	-0.09	0.91	0.84-0.98	0.018	-0.07	0.93	0.87-0.99	0.036
Sensation seeking	0.59	1.80	1.66-1.96	<0.0001	0.41	1.51	1.38-1.64	<0.0001
Alcohol policy strength x Sensation seeking	0.06	1.06	1.01-1.12	0.015	0.06	1.06	1.01-1.12	0.030
Model 3b: interaction effect alcohol policy strength x ASPD [c]								
Alcohol policy strength	-0.12	0.89	0.82-0.96	0.004	-0.09	0.91	0.85-0.98	0.012
ASPD	0.38	1.46	1.21-1.77	<0.0001	0.86	2.37	1.97-2.86	<0.0001
Alcohol policy strength x ASPD	0.15	1.17	1.03-1.31	0.012	0.14	1.15	1.02-1.29	0.023
Model 3c: interaction effect alcohol policy strength x ADHD score [d]								
Alcohol policy strength	-0.09	0.91	0.84-0.99	0.027	-0.06	0.94	0.88-1.00	0.066
ADHD score	0.01	1.01	0.99-1.03	0.33	0.08	1.08	1.06-1.10	<0.0001
Alcohol policy strength x ADHD score	0.01	1.01	0.99-1.02	0.33	0.00	1.00	0.99-1.01	0.93

Note. RSOD: Risky Single Occasion Drinking at least once a month. AUD: Alcohol Use Disorder (DSM-5). *b*: logistic regression coefficient. OR: Odds Ratio. CI: Confidence Interval. ASPD: Antisocial Personality Disorder. ADHD: Attention-Deficit/Hyperactivity Disorder

[a] mutual adjustment for the variables presented in the table as well as for depression, age, education, linguistic region, urban/rural status, and random effects for jurisdictions

[b] adjusted for ASPD, ADHD, depression, age, education, linguistic region, urban/rural status, and random effects for jurisdictions

[c] adjusted for sensation seeking, ADHD, depression, age, education, linguistic region, urban/rural status, and random effects for jurisdictions

[d] adjusted for sensation seeking, ASPD, depression, age, education, linguistic region, urban/rural status, and random effects for jurisdictions

Table 4 Probabilities of risky single occasion drinking and alcohol use disorder as predicted by multilevel logistic regressions across combinations of person-related risk factors (sensation seeking, antisocial personality disorder) and alcohol policy strength

Model 3a [a]

Outcome		Low alcohol policy strength	High alcohol policy strength
RSOD	Low sensation seeking	0.38	0.14
	High sensation seeking	0.73	0.76
AUD	Low sensation seeking	0.28	0.11
	High sensation seeking	0.46	0.53

Model 3b [b]

Outcome		Low alcohol policy strength	High alcohol policy strength
RSOD	No ASPD	0.56	0.39
	ASPD	0.52	0.58
AUD	No ASPD	0.35	0.24
	ASPD	0.44	0.51

Note. RSOD: Risky Single Occasion Drinking at least once a month. AUD: Alcohol Use Disorder (DSM-5). ASPD: Antisocial Personality Disorder.

[a] Model 3a corresponds to model 3a in table 3 and illustrates the interaction effect between sensation seeking and alcohol policy strength, adjusted for ASPD, Attention-deficit/Hyperactivity disorder, depression, age, education, linguistic region, urban/rural status, and random effects for jurisdictions. Continuous control variables were fixed at their means and categorical control variables at their proportional distribution in the sample to calculate the predicted probabilities.

[b] Model 3b corresponds to model 3b in Table 3 and illustrates the interaction effect between ASPD and alcohol policy strength, adjusted for sensation seeking, Attention-deficit/Hyperactivity disorder, depression, age, education, linguistic region, urban/rural status, and random effects for jurisdictions. Continuous control variables were fixed at their means and categorical control variables at their proportional distribution in the sample to calculate the predicted probabilities.

Table 5: Complementary analysis of the relationship between alcohol policy strength and alcohol use disorder

	PR = ASPD				PR = Sensation seeking			
	b	OR	95% CI	p-value	*b*	OR	95% CI	p-value
Model 4a [a]								
Alcohol policy strength	-0.09	0.91	0.85-0.98	0.012	-0.07	0.93	0.87-0.99	0.036
Sensation seeking	0.46	1.58	1.46-1.71	<0.0001	0.41	1.51	1.38-1.64	<0.0001
ASPD	0.86	2.37	1.97-2.86	<0.0001	0.98	2.68	2.29-3.13	<0.0001
ADHD score	0.08	1.08	1.06-1.10	<0.0001	0.08	1.08	1.06-1.10	<0.0001
Alcohol policy strength x PR	0.14	1.15	1.02-1.29	0.023	0.06	1.06	1.01-1.12	0.031
Model 4b [b]								
Alcohol policy strength	-0.09	0.91	0.85-0.98	0.012	-0.07	0.93	0.87-0.99	0.037
ADHD score	0.08	1.08	1.06-1.10	<0.0001	0.08	1.08	1.06-1.10	<0.0001
PR	0.86	2.37	1.97-2.86	<0.0001	0.41	1.51	1.38-1.64	<0.0001
Alcohol policy strength x ADHD score	0.00	1.00	0.99-1.01	0.93	0.00	1.00	0.99-1.01	0.89
Alcohol policy strength x PR	0.14	1.15	1.02-1.29	0.023	0.06	1.06	1.01-1.12	0.030

Note. PR: Person-related Risk factor (is *either* antisocial personality disorder *or* sensation seeking). AUD: Alcohol Use Disorder (DSM-5). *b*: logistic regression coefficient. OR: Odds Ratio. CI: Confidence Interval. ASPD: Antisocial Personality Disorder. ADHD: Attention-Deficit/Hyperactivity Disorder

[a] Corresponds to model 2 from Table 3 with AUD as outcome and *additionally* including the interaction effect between Alcohol policy strength and PR

[b] Corresponds to model 3c from Table 3 with AUD as outcome and *additionally* including the interaction effect between Alcohol policy strength and PR