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Alcohol-induced blackouts at age 20 predict the incidence, maintenance, and severity of alcohol dependence at age 25: A prospective study in a sample of young Swiss men

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Abstract

Background and Aims: Alcohol-induced blackout (AIB) is a common alcohol-related adverse event occurring during teenage years. Although research provides evidence that AIB predicts acute negative consequences, less is known about the associations of AIB with chronic consequences, such as alcohol dependence (AD). This study estimated the associations between an experience of AIB at age 20 and the incidence, maintenance, and severity of AD at age 25 among Swiss men.

Design: Prospective cohort study with 5.5 years separating baseline and follow-up.

Setting: Switzerland.

Participants: Swiss male drinkers (n = 5,469, age 20 at baseline) drawn from the Cohort Study on Substance Use Risk Factors (C-SURF).

Measurements: Self-report questionnaires assessing AIB, AD, alcohol (drinking volume, binge drinking), cigarette and cannabis use, several risk factors (sensation seeking, family history of problematic alcohol use, age of first alcohol intoxication) and sociodemographic variables.

Findings: Generalized estimating equation models with and without adjustment for risk factors, including alcohol use and socio-demographics, showed that AIB at age 20 significantly predicted the incidence of AD at age 25 in men without AD at age 20 (OR[95%CI], unadjusted: 2.52[2.04, 3.11], $p < .001$; fully adjusted: 1.47[1.13, 1.91], $p = .004$), maintenance of AD in men with AD at age 20 (OR[95%CI], unadjusted: 1.82[1.12, 2.95], $p = .015$; fully adjusted: 1.66[1.00, 2.76], $p = .048$), and AD severity (IRR[95%CI], unadjusted: 1.89[1.69, 2.11], $p < .001$; fully adjusted: 1.20[1.10, 1.31], $p < .001$).

Conclusions: Among Swiss men, alcohol-induced blackout at age 20 predicts the development, maintenance and severity of alcohol dependence at age 25.

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Introduction

An alcohol-induced blackout (AIB) is a partial or complete memory loss for events occurring during alcohol consumption (1). During an AIB, the person is awake and conscious, and may be engaged in any type of activity or conversation and appear perfectly oriented (2). Two biological mechanisms can underlie AIB: an encoding deficit, since ethanol temporarily inhibits the biochemical brain processes that are necessary to form new memory traces (3); and a retrieval deficit, such that the information stored in memory during intoxication is not accessible once sober (4).

AIB was first thought to be limited to alcohol dependent subjects. In an early study among approximately 2,000 recovering patients with alcohol dependence (AD), Jellinek noted frequent reports of alcohol-induced amnesia (5, 6). Later studies showed AIBs to be relatively early experiences also occurring in heavy drinkers without alcohol use disorders. A prospective evaluation involving 1,402 drinking adolescents (aged 15-19) indicated that 30% had already experienced an AIB by age 15 increasing to 74% by age 19 (7). A review of recent AIB clinical research indicated that the prevalence rate of AIB among young adults and college students averaged about 50% (8).

AIB is associated with several risk factors that are also related to alcohol dependence and consequences, such as family history of alcohol problems, patterns of alcohol use, age of first alcohol intoxication, tobacco and cannabis use, and sensation seeking (7, 9, 10). AIB is also an early sign of alcohol-related consequences. In a study conducted among 954 students, AIB at baseline was found to predict alcohol-related injury over the next two years, even after controlling for heavy drinking (11). Additional research has shown associations of AIB with suicidal ideation (12) and with increases in frustration and irritability (13). In prospective analyses of 829 US

college students, AIB in the last 3 months significantly predicted social and emotional negative consequences one year later (14).

Although there is ample evidence that AIB predicts acute negative consequences, much less is known about the associations of AIB with chronic alcohol-related consequences, such as AD, yet AIB is generally thought to reflect early warning signs of AD (5, 15). To our knowledge, only two studies have examined this notion using longitudinal designs, and they provide mixed results. In a sample of 230 US non-alcoholic young men, Anthenelli et al. (16) showed that AIB at age 18-25 years predicted AD incidence ten years later. However, the predictive power of AIB was greatly reduced when taking into account quantity and frequency of alcohol use. Wilhite and Fromme (14) found that AIB over the previous three months did not significantly predict AD during the subsequent year in college students, when adjusting for drinking quantity and other alcohol-related variables ($p=.07$); the unadjusted association was not reported. Thus, existing studies provided only partial support for the proposition that AIB predicts later AD, and suggested that general heavy drinking patterns may account for this association.

It should be noted that the aforementioned studies have some limitations. Both studies used non-representative samples of students or non-academic university staff. The one-year delay between measuring AIB and AD by Wilhite and Fromme (14) may be insufficient to capture significant changes in AD, while the research by Anthenelli et al. (16) may lack statistical power due to the small sample size. The present study used a large representative sample of young Swiss men to examine the associations between reporting an AIB at age 20 and AD at age 25, after adjustment for several risk factors.

Considering that AIB often occurs among young drinkers, the relationship between an early experience of AIB and subsequent development of AD has the potential for developing clinical

and preventive interventions, because first AIBs generally occur before age 20, while the onset of AD typically occurs during the mid-twenties (17).

Onset of AD may already occur at age 20 or earlier (18-22), but then also often matures out in early adulthood. Vergés et al. (23) found that only approximately 30% of participants meeting the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV) criteria for AD at age 18-20 were still classified as dependent three years later. Thus, approximately 70% of those meeting AD criteria in their early twenties “matured out” of this disorder three years later. For those individuals meeting AD criteria at age 20, we made the hypothesis that an early experience of AIB might be a predictor of the maintenance of AD at age 25.

The aims of the present study were to investigate whether AIB at age 20 predicts:

- the incidence of AD at age 25 in individuals without AD at age 20,
- the maintenance of AD at age 25 in individuals with AD at age 20,
- AD severity at age 25 in the total sample.

If AIB at age 20 predicts AD at age 25, a history of AIB would have the potential for creating early preventive measures, especially since AIB is highly prevalent in the late teenage years.

Methods

Study Design and Participants

Data were drawn from the Cohort Study on Substance Use Risk Factors (C-SURF), a longitudinal study designed to investigate risk and protective factors related to substance use in emerging adulthood. The research protocol (15/07) was approved by the ethics committee for clinical research of the Lausanne University Medical School. Enrolment took place in three of the six army recruitment centres, covering 21 of the 26 Swiss cantons. Questionnaires were completed

at home, independent of army procedures. Since army recruitment is mandatory for nineteen-year-old males in Switzerland, virtually all were eligible for participation.

A total of 13,237 young men were informed of the study and 7,556 (57.1%) men gave written consent to participate. Among them, 5,987 (79.2%) completed a baseline questionnaire between September, 2010 and March, 2012. Enrolment procedures and nonresponse and nonconsent biases are described in more detail in previous publications (24-26). Although significant differences were found between consenters and nonconsenters and respondents and nonrespondents, the magnitude of the nonconsent and nonresponse biases were small (<10%) for drinking status and binge drinking. Among baseline respondents, 5,125 completed a follow-up questionnaire between April, 2016 and March, 2018, equalling an 85.6% retention rate. The mean age of participants was 19.95 (SD=1.22) at baseline and 25.41 (SD=1.24) years at follow-up, with an average interval of 5.46 (SD=0.40) years. Excluded were 518 (8.6%) respondents who reported no alcohol use in the last twelve months before baseline. As opposed to respondents, nonrespondents at follow-up reported significantly more vocational training and less post-secondary schooling as highest education level achieved ($p<.001$), and were older ($p<.001$) at baseline. By contrast, they did not differ significantly with regard to binge drinking, AIB, and AD severity (all p -values $\geq .124$). Missing values for variables of interest were observed in 910 (16.6%) baseline drinkers. Most of the missing values were observed for AD at age 25 ($n=783$, 14.3%), whereas 1.0% of missing values or less were found for the other variables of interest (Table S1). Missing values were imputed using multiple imputation (MI) with fully conditional specification for 20 datasets. Scale variables were imputed using predictive mean matching whereas categorical variables were imputed using (multinomial) logistic regression. The final imputed samples

consisted of 5,469 participants, 608 (11.1%) meeting AD and 4,861 (88.9%) not meeting AD criteria at age 20.

Measures

DSM-IV alcohol dependence. At age 20 and at age 25, participants were asked whether they had experienced any of the 7 AD criteria referenced by the DSM-IV (27) in the previous 12 months: tolerance; withdrawal symptoms; using larger amounts and for longer periods than intended; desire to cut down alcohol use unsuccessfully; spending a great deal of time obtaining, consuming or recovering from the effects of alcohol; giving up important activities because of drinking; and continued drinking despite awareness that alcohol had repeatedly caused anxiety, depression or health problems. Endorsed items were summed to obtain the number of AD criteria, ranging from 0 to 7, and the score was used to measure AD severity. According to DSM-IV guidelines, AD was defined as endorsing three or more criteria. AD at age 25 was used as the dependent variable in the analyses of incidence and maintenance of AD.

AIB. At age 20, participants were asked whether or not they had experienced a blackout after drinking alcohol in the previous 12 months (yes or no). The wording of the item differed slightly between the French and German versions of the questionnaire. In the French version, the wording was “I had a blackout after drinking alcohol (I could not remember anything)”, thus referring to a complete AIB, whereas the wording of the German version, was “I had a blackout after drinking alcohol (I could not remember anything or only fragments)”, thus referring to complete or partial blackout. We tested whether linguistic region moderated the associations between AIB at age 20 and AD at age 25. The interaction between AIB and linguistic region did reach significance neither on incidence ($p=.811$), maintenance ($p=.390$) of AD, nor AD severity

($p=.155$), providing no evidence that the wording difference may have affected the results. AIB was used to predict the incidence and maintenance of AD and AD severity at age 25.

Potential confounding variables. Based on previous studies, potential confounders were selected as risk factors for AD and AIB, namely family history of problematic alcohol use (9, 28), drinking volume and binge drinking (10, 29), age of first alcohol intoxication (10, 30), cannabis and cigarette use (7, 31), and sensation seeking (7, 32). All potential confounding variables were assessed at age 20.

Weekly drinking volume (DV). A quantity-frequency measure was constructed to estimate weekly drinking volume at baseline. Participants were asked to report the usual frequency of drinking occasions and the usual quantity (number of standard drinks) per occasion in the previous twelve months, separately for weekdays and weekends. Weekday and weekend DV were obtained by multiplying frequency and quantity, while weekly DV was obtained by summing weekday and weekend DV.

Binge drinking was defined as consuming six or more standard drinks on a single occasion, at least once monthly. Since standard drinks contain 10-12g of pure alcohol in Switzerland, our cut-off is at approximately 66g of pure alcohol and corresponds approximately to the definition of the National Institute on Alcohol Abuse and Alcoholism (NIAAA), i.e. for men, approximately 70g of pure alcohol, corresponding to five drinks containing 14g of pure alcohol (33, 34).

Age of first alcohol intoxication. Participants were asked how old they were when they were intoxicated for the first time. Those reporting their first intoxication at age 15 or before were compared with those reporting their first intoxication after age 15, or never.

Family history of problematic alcohol use (FH) was measured using a series of questions from the Alcohol, Smoking and Substance Involvement Screening Test (ASSIST; 35) asking

participants whether any of their father, mother, grandfathers, grandmothers, aunts or uncles had a significant drinking problem that led to treatment (or should have). FH positive (FH+) was defined as reporting at least one positive response versus FH negative (FH-), where no family problematic alcohol use was noted.

Smoking status. Participants were asked how often they smoked cigarettes in the previous 12 months, and were categorized as non-, occasional, or daily smokers.

Cannabis use status. Participants were asked how often they had used cannabis in the previous 12 months, and were categorized as non-, less than twice a week, and at least twice a week cannabis users.

Sensation seeking (SS) was assessed using the eight-item Brief Sensation Seeking Scale (BSSS; 36). Each item was on a five-point scale ranging from 1–“strongly disagree” to 5–“strongly agree”. Cronbach’s alpha in the present study ($\alpha = .81$) was slightly higher than that observed in the validation study of the BSSS ($\alpha = .76$), indicating good scale score reliability. A mean score ranging from 1 to 5 was computed, where high scores reflect high levels of sensation seeking.

Sociodemographic and adjustment variables. At age 20, participants were asked to report their perception of their family income (average, below average, or above average) and their highest education level achieved (primary schooling: 9 years, vocational training: about 12 years, and post-secondary schooling: 13 years or more, including high school), as well as age, linguistic region (German- or French-speaking). The timespan (in years) between baseline and follow-up questionnaire was additionally used as adjustment.

Statistical Analyses

Analyses were conducted using IBM SPSS Statistics 25 (37). Descriptive statistics were calculated to characterize the sample. Bivariate associations between baseline variables were

tested using Spearman correlations. Changes in AD and AD severity were tested using McNemar's Chi-square test and paired t-test, respectively. Associations between AIB at age 20 and AD and AD severity at age 25 were tested using Generalized Estimating Equation (GEE) models using a binomial and a negative binomial distribution, respectively, and accounting for the clustering effect of cantons of enrolment. For each outcome, four models with increased number of adjustment variables were tested. Only AIB was entered in model 1, AIB and AD severity at age 20 were entered in model 2. Variables entered in model 3 were the same as in model 2 plus sociodemographic adjustment variables (highest education level achieved, perceived family income, age, linguistic region) and the timespan between questionnaires. Model 4 tested the variables entered in model 3 plus potential confounding variables associated with the development of AD (FH, binge drinking, age of first intoxication, weekly DV, sensation seeking, smoking and cannabis use). Models predicting the incidence and maintenance of AD and AD severity at age 25 were analysed separately. Analyses of incidence of AD at age 25 were conducted on participants not meeting AD criteria at age 20, analyses of maintenance of AD at age 25 were conducted on those meeting AD criteria at age 20, whereas analyses of AD severity at age 25 were conducted on the total sample. Estimates and confidence intervals were pooled across the 20 MI datasets. Sensitivity analyses conducted on the complete cases (N=4,686) led to the same conclusions as with MI. As suggested by an anonymous reviewer, we also tested the reverse associations: AD at age 20 predicted AIB at age 25 ($OR_{adjusted}[95\%CI]=1.48[1.20, 1.82]$, $p<.001$). More details are given in Tables S4 and S5.

Results

Descriptive Characteristics of the Sample

Baseline characteristics of the total sample, of participants meeting AD and not meeting AD are reported in Table 1, S2 and S3, respectively. Prevalence of AD decreased significantly, from 11.1% at age 20 to 8.4% at age 25 ($\chi^2_{\text{McNemar}(1)} = 17.53, p < .001$), as did AD severity, from 0.87 to 0.80 ($t(5468) = 4.17, p < .001$). Among participants meeting AD criteria at age 20, 26.5% were also dependent at age 25. Among participants not meeting AD criteria at age 20, 6.2% were dependent at age 25. About one third (32.3%) of the participants reported an AIB at age 20, and 57.4% (265/462) of those meeting AD criteria at age 25 reported an AIB at age 20.

Associations of AIB at Age 20 with Incidence and Maintenance of Alcohol Dependence at Age 25

GEE models showed that among participants not meeting AD criteria at age 20, those having an AIB at age 20 had higher odds to report AD at age 25 than those reporting no AIB (10.5% vs. 4.5% [Table 2], OR[95%CI]=2.52[2.04, 3.11], $p < .001$ [Table 3, Model 1]). This association remained significant even after adjustment for baseline AD severity, sociodemographic variables, and risk factors, including alcohol use measures (OR[95%CI]=1.47[1.13, 1.91], $p = .004$, Table 3, Model 4), indicating that the odds of incidence of AD at age 25 were 47% higher in those reporting an AIB at age 20 (vs. no AIB). Among participants meeting AD criteria at age 20, maintenance of AD at age 25 was more prevalent in those having an AIB at age 20 than in those having no AIB at age 20 (30.6% vs. 19.3% [Table 2], OR[95%CI]=1.82[1.12, 2.95], $p = .015$ [Table 4, Model 1]). This association remained significant even after adjustment for baseline AD severity, sociodemographic, and risk factors including alcohol use measures (OR[95%CI]=1.66[1.00, 2.76], $p = .048$, Table 4, Model 4), indicating that the odds of maintenance of AD at age 25 was 66% higher in those reporting an AIB at age 20 (vs. no AIB).

Associations of AIB at Age 20 with Alcohol Dependence Severity at Age 25

In the total sample, participants having an AIB at age 20 reported higher AD severity scores at age 25 than those having no AIB at age 20 (1.17 vs. 0.62, IRR[95%CI]=1.89[1.69, 2.11], $p < .001$ [Table 5, Model 1]). This association remained significant even after adjustment for baseline AD severity, sociodemographic, and risk factors including alcohol use measures (IRR[95%CI]=1.20[1.10, 1.31], $p < .001$, Table 5), indicating that AD severity at age 25 was 20% higher in those reporting an AIB at age 20 (vs. no AIB).

Discussion

This study showed that AIB was significantly associated with the incidence and maintenance of AD, and with AD severity at age 25. These associations remained significant even after adjustment for sociodemographic and several potential confounding variables, including AD severity and other alcohol use measures at age 20. This suggests that AIB is an independent predictor of AD incidence, maintenance and severity.

Our unadjusted findings are in line with results of Anthenelli et al. (16). However, the finding that the associations remained significant after adjusting for sociodemographic and several alcohol-related variables and risk factors differs from earlier research (14, 16). In fact, previous studies suggest that AIB itself may not contribute to later AD, but rather is related to the large amounts of alcohol use associated with AIB. The results herein are more in line with Jellinek (5). This suggests that AIB may be an early warning sign for later AD incidence as well as an indicator of AD maintenance. However, given the small effect size of AIB, the implications of this finding should not be overestimated.

Results also indicated that among participants meeting AD criteria at age 20, only 26.5% still met the criteria at age 25. This finding is in line with that of Vergés et al. (23), and points out the low persistence of AD from late adolescence to young adulthood. These results support the need to identify factors, such as AIB, that may help to differentiate between subsequent remission and persistence of AD.

The results of the present study may have some important implications for clinical and preventive interventions. First, given the transient nature of an AD diagnosis in early adulthood, the identification of individuals reporting AIB could yield valuable clinical information. Moreover, 57.4% of participants reporting AD at age 25 experienced an AIB at age 20. Although effect sizes were small in GEE models, AIB can be easily assessed so it may be useful in screening tools for individuals at risk for developing or maintaining later AD. Second, besides its association with AD, AIB was found to be associated with several other negative consequences in previous studies (11-14). This suggests that interventions designed to prevent or reduce the occurrence of AIB may also be beneficial. The use of personalized feedback to inform individuals about their own risk and consequences have shown promising results (38). Perceived risk can mediate reactions to interventions for unhealthy alcohol use (39). The anticipation of negative health outcomes, and the desire to avoid them, are hypothesized to create motivation for self-protection (40-42). As such, noting the correlates of AIB may be a vital component of personalized feedback.

This study is not without limitations. The sample included young men only, and further study is needed to investigate whether the pattern of associations observed may be generalized to women and other age groups. The DSM-IV AD criteria were developed for clinical interviews and the validity of this measure in self-administered modes is unknown. Further studies using clinical interviews or more standardized measure of AD (e.g. AUDIT; 43) are warranted. The question

about AIB simply asked whether or not AIB was experienced in the 12 months before baseline assessment (at age 20). This does not account for the frequency of AIB or whether it already occurred before age 19. Further studies are needed to ensure that AIB is assessed accurately and is understood correctly by the participants. Although statistically significant, the adjusted OR and IRR for AIB observed in the present study reflected effect sizes of small magnitude, according to Olivier et al. (44). The sample represents approximately 45% of the eligible subjects. However, analyses of nonconsent and nonresponse showed that associated biases were small (<10%) suggesting that they had little influence on the findings (25, 26). Finally, we cannot exclude that the lack of accounting for unmeasured confounding factors, as well as the measurement error of some measured confounders, may partially have biased the results.

In conclusion, AIB at age 20 predicts the incidence and maintenance of AD, as well as AD severity at age 25 and constitutes an early sign of impending problems. Clinicians should take into account that young patients who report AIB are at higher risk for current or future AD and should provide counselling, diagnostic assessment for alcohol-related problems (including AD), and, if needed, targeted care.

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Table 1. Baseline characteristics of the sample (n = 5469).

		Spearman correlations (ρ)													
		1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. AIB (n, %)	1765, 32.3%														
2. AD (n, %)	608, 11.1%	.248													
3. AD severity (M, SD)	0.87, 1.23	.346	.599												
4. At least monthly binge drinking (n, %)	2755, 50.4%	.320	.228	.379											
5. Weekly drinking volume (M, SD standard drinks)	9.14, 10.49	.334	.304	.450	.692										
6. Age of first intoxication (n, % 15 or before)	2451, 44.8%	.212	.165	.208	.296	.334									
7. FH+ (n, %)	1283, 23.5%	.044	.067	.095	.038	.047	.061								
8. Smoking status		.117	.133	.186	.227	.295	.294	.134							
Non-smokers (n, %)	2729, 49.9%														
Occasional smokers (n, %)	1524, 27.9%														
Daily smokers (n, %)	1216, 22.2%														
9. Cannabis use status		.187	.146	.206	.267	.308	.322	.107	.462						
Non users (n, %)	3675, 67.2%														
Less than twice a week (n, %)	1229, 22.5%														
Twice a week or more often (n, %)	565, 10.3%														
10. Linguistic region		.135	.033	.047	.014	.025	.017	-.111	-.018	-.047					
German-speaking (n, %)	2480, 45.3%														
French-speaking (n, %)	2989, 54.7%														
11. Perceived family income		-.039	-.001	.000	-.035	-.038	-.017	.089	.064	.016	-.144				
Above average (n, %)	2464, 45.1%														
Average (n, %)	2254, 41.2%														
Below average (n, %)	751, 13.7%														
12. Highest education level achieved		-.060	-.016	-.019	-.003	-.005	-.002	.034	-.047	-.016	-.287	-.017			
Primary schooling (n, %)	2657, 48.6%														
Vocational training (n, %)	1655, 30.3%														
Post-secondary schooling (n, %)	1157, 21.1%														
13. Age (M, SD)	19.97, 1.22	-.079	-.005	-.036	-.045	-.035	-.014	.087	.089	.044	-.288	.103	.276		
14. Sensation seeking (M, SD)	3.09, 0.86	.243	.144	.229	.258	.302	.272	.040	.225	.290	.161	-.017	-.069	-.032	

15. Timespan between the baseline
and follow-up questionnaires
(M, SD)

5.47, 0.42 -0.002 .000 -.019 -.021 -.013 .023 .011 .033 .018 .055 -.010 -.096 -.121 .029

Note. AIB: Alcohol induced blackout. AD: Alcohol dependence. FH+: Family history of problematic alcohol use. M: mean. SD: Standard deviation. $|\rho| \geq .029$ and $\leq .034$ are significant at $p < .05$. $|\rho| \geq .035$ and $\leq .044$ are significant at $p < .01$. $|\rho| \geq .045$ are significant at $p < .001$.

Table 2. Alcohol dependence at age 25 as a function of alcohol dependence and AIB at age 20

		n		% ^a		Alcohol dependence at age 25 ^b			
						No		Yes	
		n	% ^a	n	%	n	%		
Total		5469	100.0	5007	91.6	462	8.4		
Alcohol dependence at age 20									
No		4861	88.9	4560	93.8	301	6.2		
Yes		608	11.1	447	73.5	161	26.5		
AIB at age 20									
No		3704	67.7	3507	94.7	197	5.3		
Yes		1765	32.3	1500	85.0	265	15.0		
AIB at age 20 (among non-dependent at age 20, n = 4861)									
No		3492	71.8	3336	95.5	156	4.5		
Yes		1369	28.2	1225	89.5	144	10.5		
AIB at age 20 (among dependent at age 20, n = 608)									
No		212	34.9	171	80.7	41	19.3		
Yes		396	65.1	275	69.4	121	30.6		

Note. AIB = Alcohol-induced blackout. ^aColumn percentages. ^bRow percentages.

Table 3. AIB at age 20 predicting incidence of alcohol dependence at age 25 among participants not meeting DSM-IV alcohol dependence criteria at age 20 (n = 4861)

	Model 1 (QIC = 2200.38)			Model 2 (QIC = 2136.44)			Model 3 (QIC = 2135.72)			Model 4 (QIC = 2089.42)		
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
AIB (ref. no)	2.52	2.04, 3.11	<.001	1.88	1.48, 2.39	<.001	1.88	1.48, 2.38	<.001	1.47	1.13, 1.91	.004
AD severity				1.88	1.53, 2.31	<.001	1.89	1.55, 2.32	<.001	1.60	1.32, 1.95	<.001
Education (ref. primary schooling)												
Vocational training							0.80	0.62, 1.06	.119	0.76	0.57, 1.01	.063
Post-secondary schooling							0.87	0.64, 1.18	.371	0.92	0.67, 1.27	.635
Perceived family income (ref. Average)												
Above average							1.31	0.96, 1.79	.087	1.23	0.88, 1.73	.221
Below average							1.27	0.98, 1.63	.066	1.26	0.97, 1.63	.079
Linguistic region (ref. French-speaking)							0.92	0.72, 1.16	.508	0.92	0.73, 1.16	.503
Timespan between questionnaires							1.22	0.98, 1.53	.079	1.16	0.93, 1.44	.174
Age							1.00	0.90, 1.11	.973	0.97	0.87, 1.09	.644
FH+ (ref. FH-)										1.21	0.86, 1.70	.279
At least monthly binge drinking										1.29	0.97, 1.72	.075
Age of first intoxication, at 15 or before										1.33	1.02, 1.74	.035
Weekly DV										1.01	1.00, 1.03	.047
Smoking status (ref. non-smokers)												
Occasional smokers										1.29	0.93, 1.80	.126
Daily smokers										1.50	0.98, 2.29	.060
Cannabis use status												
Less than twice a week										0.91	0.62, 1.32	.611
Twice a week or more										1.15	0.78, 1.68	.467
Sensation seeking (range 1-5)										1.27	1.07, 1.52	.007

Note. AIB: alcohol-induced blackout. OR: odds ratio. CI: confidence interval. DV: drinking volume. AD: alcohol dependence. FH+: Positive family history of problematic alcohol use. QIC: Quasi-likelihood information criterion. Independent variables: Model 1: AIB. Model 2: AIB and AD severity. Model 3: model 2 plus sociodemographic adjustment variables (highest education level achieved, perceived family income, age, timespan between questionnaires and linguistic region). Model 4: model 3 plus FH, binge drinking, age of first intoxication, weekly DV, sensation seeking, and smoking and cannabis use status.

Table 4. AIB at age 20 predicting maintenance of alcohol dependence at age 25 among participants meeting DSM-IV alcohol dependence criteria at age 20 (n = 608)

	Model 1 (QIC = 699.18)			Model 2 (QIC = 697.79)			Model 3 (QIC = 697.43)			Model 4 (QIC = 701.31)		
	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p	OR	95% CI	p
AIB (ref. no)	1.82	1.12, 2.95	.015	1.74	1.08, 2.82	.023	1.70	1.02, 2.82	.041	1.66	1.00, 2.76	.048
AD severity				1.18	0.97, 1.43	.092	1.16	0.94, 1.43	.154	1.10	0.88, 1.37	.379
Education (ref. primary schooling)												
Vocational training							0.94	0.59, 1.52	.830	0.90	0.56, 1.44	.657
Post-secondary schooling							0.55	0.29, 1.02	.060	0.56	0.33, 0.96	.034
Perceived family income (ref. Average)												
Above average							1.39	0.86, 2.25	.181	1.41	0.85, 2.34	.184
Below average							1.55	1.14, 2.10	.005	1.53	1.13, 2.07	.006
Linguistic region (ref. French-speaking)							0.88	0.56, 1.39	.589	0.91	0.55, 1.50	.708
Timespan between questionnaires							0.76	0.49, 1.17	.213	0.73	0.46, 1.15	.177
Age							1.05	0.90, 1.23	.524	1.05	0.88, 1.25	.592
FH+ (ref. FH-)										0.93	0.58, 1.49	.756
At least monthly binge drinking										0.85	0.42, 1.71	.647
Age of first intoxication, at 15 or before										1.08	0.62, 1.88	.780
Weekly DV										1.01	1.00, 1.02	.016
Smoking status (ref. non-smokers)												
Occasional smokers										1.56	0.85, 2.89	.149
Daily smokers										1.33	0.75, 2.38	.325
Cannabis use status (ref. non-users)												
Less than twice a week										1.34	0.74, 2.41	.334
Twice a week or more										1.40	0.70, 2.77	.337
Sensation seeking (range 1-5)										1.05	0.79, 1.39	.726

Note. AIB: alcohol-induced blackout. OR: odds ratio. CI: confidence interval. DV: drinking volume. AD: alcohol dependence. FH+: Positive family history of problematic alcohol use. QIC: Quasi-likelihood information criterion. Independent variables: Model 1: AIB. Model 2: AIB and AD severity. Model 3: model 2 plus sociodemographic adjustment variables (highest education level achieved, perceived family income, age, timespan between questionnaires and linguistic region). Model 4: model 3 plus FH, binge drinking, age of first intoxication, weekly DV, sensation seeking, and smoking and cannabis use status.

Table 5. AIB at age 20 predicting alcohol dependence severity at age 25 among the total sample (n = 5469)

	Model 1 (QIC = 7099.83)			Model 2 (QIC = 6557.03)			Model 3 (QIC = 6550.00)			Model 4 (QIC = 6347.38)		
	IRR	95% CI	p	IRR	95% CI	p	IRR	95% CI	p	IRR	95% CI	p
AIB (ref. no)	1.89	1.69, 2.11	<.001	1.43	1.32, 1.56	<.001	1.41	1.29, 1.53	<.001	1.20	1.10, 1.31	<.001
AD severity				1.30	1.25, 1.34	<.001	1.30	1.25, 1.35	<.001	1.21	1.17, 1.26	<.001
Education (ref. primary schooling)												
Vocational training							0.89	0.81, 0.97	.008	0.87	0.80, 0.95	.002
Post-secondary schooling							1.02	0.95, 1.10	.566	1.04	0.97, 1.12	.259
Perceived family income (ref. Average)												
Above average							1.03	0.91, 1.15	.677	1.01	0.89, 1.14	.896
Below average							1.06	0.99, 1.15	.103	1.05	0.97, 1.14	.228
Linguistic region (ref. French-speaking)							1.08	0.99, 1.17	.097	1.09	1.01, 1.19	.033
Timespan between questionnaires							1.00	0.93, 1.07	.914	0.98	0.91, 1.05	.597
Age							0.97	0.94, 1.00	.051	0.97	0.87, 1.09	.644
FH+ (ref. FH-)										1.21	0.86, 1.70	.279
At least monthly binge drinking										1.29	0.97, 1.72	.075
Age of first intoxication, at 15 or before										0.97	0.94, 0.99	.030
Weekly DV										1.01	1.00, 1.01	<.001
Smoking status (ref. non-smokers)												
Occasional smokers										1.09	0.97, 1.23	.138
Daily smokers										1.12	0.97, 1.28	.114
Cannabis use status (ref. non-users)												
Less than twice a week										1.13	1.04, 1.23	.006
Twice a week or more										1.17	1.03, 1.33	.013
Sensation seeking (range 1-5)										1.11	1.06, 1.16	<.001

Note. AIB: alcohol-induced blackout. IRR: incidence rate ratio. CI: confidence interval. DV: drinking volume. AD: alcohol dependence. FH+: Positive family history of problematic alcohol use. QIC: Quasi-likelihood information criterion. Independent variables: Model 1: AIB. Model 2: AIB and AD severity. Model 3: model 2 plus sociodemographic adjustment variables (highest education level achieved, perceived family income, age, timespan between questionnaires and linguistic region). Model 4: model 3 plus FH, binge drinking, age of first intoxication, weekly DV, sensation seeking, and smoking and cannabis use status).