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Independent and combined associations of risky single-occasion drinking and drinking volume with alcohol use disorder: Evidence from a sample of young Swiss men

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Running head: Alcohol use patterns and alcohol use disorder.

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Abstract

Aims. Risky single-occasion drinking (RSOD) is a prevalent and potentially harmful alcohol use pattern associated with increased alcohol use disorder (AUD). However, RSOD is commonly associated with a higher level of alcohol intake, and most studies have not controlled for drinking volume (DV). Thus, it is unclear whether the findings provide information about RSOD or DV. This study sought to investigate the independent and combined effects of RSOD and DV on AUD.

Methods. Data were collected in the longitudinal Cohort Study on Substance Use Risk Factors (C-SURF) among 5,598 young Swiss male alcohol users in their early twenties. Assessment included DV, RSOD, and AUD at two time points. Generalized linear models for binomial distributions provided evidence regarding associations of DV, RSOD, and their interaction.

Results. DV, RSOD, and their interaction were significantly related to the number of AUD criteria. The slope of the interaction was steeper for non/rare RSOD than for frequent RSOD.

Conclusions. RSOD appears to be a harmful pattern of drinking, associated with increased AUD and it moderated the relationship between DV and AUD. This study highlighted the importance of taking drinking patterns into account, for both research and public health planning, since RSO drinkers constitute a vulnerable subgroup for AUD.

Keywords: Cohort study; internal dysfunction; longitudinal; variability of drinking

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1. Introduction

Risky single-occasion drinking (RSOD) is a common pattern of alcohol use associated with several detrimental acute and chronic consequences (Adam et al., 2011; Courtney and Polich, 2009; Daeppen et al., 2005; Dupuis et al., 2014; Gmel et al., 2006a; Gmel et al., 2011; Kuntsche and Gmel, 2013; Kuntsche et al., 2004). RSOD is defined as heavy use of alcohol over a short period of time - specifically, as heavy alcohol use on a single occasion (Gmel et al., 2011; Murgraff et al., 1999). It is a dimension of alcohol use related to variability of drinking (Rehm and Gmel, 2000). Drinking about 60 grams of pure ethanol or more on a single occasion serves as a threshold value for defining RSOD (Gmel et al., 2011), specifically for males, 6 drinks or more with 10 grams per standard drink, or 5 drinks or more with 12 grams per standard drink.

Among different consequences and detrimental associations, earlier studies showed that risky single-occasion (RSO) drinkers are more likely to be diagnosed with alcohol use disorder (AUD) than non-RSO drinkers (Knight et al., 2002). Thus, patterns of drinking such as RSOD and drinking volume (DV) may have an independent and combined effect with AUD (Rehm and Gmel, 2000).

However, these independent and combined effects of RSOD and DV with AUD are often not assessed. The independent effect of RSOD on AUD, DV is often not controlled for when studying the effect of RSOD (Gmel et al., 2011). RSOD, however, is commonly associated with a higher level of alcohol intake (Dawson et al.,

2008). Since most studies did not adjust for DV, it is therefore unclear whether the findings provided information about RSOD or about large DV.

Additionally, very few studies have tackled the interaction between DV and RSOD, and thus assessed their combined effect. Viner and Taylor (2007) investigated the interaction between these two variables, and found that the interaction term (binge drinking and regular alcohol use) was not significantly associated with the adult outcomes. However, RSOD was measured on self-reported use over only two weeks preceding the survey. Overall, few studies have included the combined effect of RSOD and DV in their models, even for other alcohol-related consequences; for example, the risk of impaired driving (Dawson, 1999), the risk of injury (Gmel et al., 2006b), hazardous driving behavior (Valencia-Martín et al., 2008) and alcohol-related social harm (Kraus et al., 2009). Moreover, because these studies compared different groups of drinkers such as moderate drinkers with/without RSOD, and heavy drinkers with/without RSOD, they could not test nor directly quantify the strength of an interaction between DV and RSOD. Thus, more studies are needed to determine how alcohol use patterns influence AUD, with both independent and combined effects with DV.

This study aimed to fill in these gaps in a representative sample of young Swiss men, and sought to test the independent and combined effects of RSOD and DV on AUD, using a prospective design.

2. Methods

2.1. Participants and procedures

Participants were enrolled in the Cohort Study on Substance Use Risk Factors (C-SURF). C-SURF is a longitudinal study designed to assess substance use patterns

among young Swiss men. Enrollment took place in three of Switzerland's six army recruitment centres located in Lausanne (French-speaking), Windisch, and Mels (German-speaking), which covered 21 of the country's 26 cantons. All French-speaking cantons were included. Army recruitment procedure is mandatory for all young Swiss men around 20 years old and there is no pre-selection for this conscription. Thus, the sample is representative of all Swiss men in their early twenties. Army recruitment centers were used to inform and enroll participants, but the study was independent of the army and of individuals' eligibility for military service. Moreover, the assessment was carried out outside of the army environment.

A total of 5,990 participants filled in the baseline questionnaire (data was collected between September 2010 and March 2012); and 5,223 (87.2%) completed the follow-up questionnaire (January 2012-April 2013). An average of 15 ± 2.8 months separated the two assessments.

This study focused on a sample consisting of alcohol users, who reported using alcohol at both baseline and follow-up (n = 4,598). Listwise deletion was executed due to missing values, so that the final sample consisted of 4,471 participants (97.2% of the alcohol users). A previous study about sampling and non-response bias reported a small non-response bias (Studer et al., 2013). Lausanne University Medical School's Clinical Research Ethics Committee approved the study protocol (No. 15/07).

2.2. Measures

DSM-5 alcohol use disorder. AUD was assessed on the basis of the eleven criteria for alcohol dependence reported in DSM-5 (American Psychiatric Association, 2013). A summary score of criteria was used (from 0 to 11) instead of

the cut-offs described in the DSM-5. Previous studies reported that a continuous dimension better fitted AUD than a categorical one (Kerridge et al., 2013).

Drinking volume. Volume of alcohol intake was measured with the extended quantity-frequency (QF) measurement questionnaire. It provided information about the usual number of drinking days and the quantity consumed per drinking day, distinguishing between weekends and weekdays. These measures were converted into a total number of drinks per week and DV was considered as a continuous variable. For a complete description and comparison with other questionnaires measuring alcohol use, see Gmel et al. (2014).

RSOD. RSOD frequency was assessed using the standard measure from the Alcohol Use Disorder Identification Test (AUDIT). Participants were asked how often they drank a quantity of six drinks or more on a single occasion over the previous twelve months (10g of ethanol per drink). Answers were collected on a 5-point scale (no RSOD, less than monthly RSOD, monthly RSOD, weekly RSOD, daily RSOD). Weekly or more frequent RSOD being coded '1', otherwise '0'.

All alcohol-related variables were assessed over the previous twelve months and were included in the baseline and the follow-up questionnaires.

Covariates. Age of first alcohol use was assessed. Demographic covariates included age, language (French- or German-speaking), level of education attained ('lower secondary', 'upper secondary', 'tertiary'), and perceived family income as a proxy for level of income ('below average income', 'average income', 'above average income').

2.3. Statistical analyses

First, descriptive statistics were computed, including the prevalence of RSOD, and mean scores of AUD criteria and DV.

Second, cross-sectional associations of DV and RSOD with AUD were performed, separately for baseline and follow-up. We used Generalized Linear Models (GLM for negative binomial distribution). The two models regressed the number of AUD criteria on DV (extended QF questionnaire), RSOD, and the interaction between DV and RSOD.

Third, the longitudinal association of DV and RSOD with AUD was tested, again using GLM (negative binomial distribution). The number of AUD criteria at follow-up was regressed on DV (extended QF questionnaire), RSOD, and the interaction between DV and RSOD at baseline.

The models controlled for demographic covariates, and age at first alcohol use. The number of AUD criteria at baseline, DV at follow-up, and RSOD at follow-up were also controlled for in the longitudinal model. A sensitivity analysis further performed all models using the RSOD variables coded as continuous (no binge = 0, less than monthly RSOD = 6, monthly RSOD = 12, weekly RSOD = 52, daily RSOD = 364). Results were similar in their significance and interpretation. Additionally, we performed all models using the logged DV, because this variable was skewed. Since results were similar, we kept the non-logged variable because it made interpretation easier. Finally, we performed an alternative model to control for outliers (especially for non/rare RSO drinkers): we selected the participants who reported drinking 28 drinks per week or less, and estimated the models described earlier. Results were the same as those of the models including all participants.

All analyses were conducted using SPSS 21 software and R.

3. Results

3.1. Preliminary results

Participants were 19.9 ± 1.2 years old on average at baseline and 21.2 years old at follow-up, and 53.8% were French-speaking. They used alcohol for the first time at 14.3 ± 1.8 years old on average. At baseline, 49.3% of the participants had a lower secondary level of education, 23.9% an upper secondary level of education, and 26.8% a tertiary level of education. A total of 13.3% of the participants reported a perceived family income below average, and 46.3% above average.

As reported in Table 1, 24.7% of the participants reported frequent RSOD (weekly or more) at baseline, and 22.9% at follow-up. They reported a consumption of 5.67 drinks per week on average at baseline, and 5.85 at follow-up. Heavy alcohol use was rare: 79% of the participants drank two drinks or less per day on average (not shown in Table 1). Participants reported low scores of AUD at both baseline and follow-up (respectively 1.38 and 1.35).

3.2. Cross-sectional associations of RSOD and DV with AUD

The first panel of Table 2 summarizes the results of cross-sectional associations. Results showed that both DV and RSOD were significantly related to the number of criteria for AUD (respectively $\beta_{DV} = 0.069$, $p < .001$ and $\beta_{RSOD} = 1.002$, $p < .001$ at baseline; $\beta_{DV} = 0.068$, $p < .001$ and $\beta_{RSOD} = 0.972$, $p < .001$ at follow-up). These results provided information on the independent effects of RSOD and DV. The interaction term was also significant ($\beta_{interaction} = -0.052$, $p < .001$ at baseline; $\beta_{interaction} = -0.049$, $p < .001$ at follow-up), and the negative parameter indicated that the slope of the relationship between DV and AUD was steeper among non-/rare RSO drinkers (coded 0) than among frequent RSO drinkers (coded 1). Indeed, among frequent RSO

drinkers, the slopes associated with DV when the interaction term was taken into account were close to zero ($\beta_{RSO\ drinkers}$ = 0.017 at baseline and $\beta_{RSO\ drinkers}$ = 0.019 at follow-up), whereas they were positive for non-/rare RSO drinkers ($\beta_{drinking\ volume}$ = 0.069 at baseline and $\beta_{drinking\ volume}$ = 0.068 at follow-up). The graph in Figure 1 summarizes this result (baseline).

3.3. Longitudinal associations of RSOD and DV with AUD

The second panel of Table 2 provides the results of longitudinal associations. There were independent effects of DV and RSOD at baseline on the number of criteria for AUD at follow-up (respectively β_{DV} = 0.013, p = .008; and β_{RSOD} = 0.343, p < .001). The interaction term was also significant and negative ($\beta_{interaction}$ = -.027, p < .001). Therefore, the number of criteria for AUD at follow-up increased more strongly with DV at baseline among non-RSO drinkers (coded 0) than among RSO drinkers (coded 1).

4. Discussion

This study aimed to test the independent and combined effects of DV and RSOD on AUD, using a prospective design.

First, larger DV was associated with an increased number of criteria for AUD. This result is in line with previous studies showing that AUD is more likely to occur among heavy alcohol users (Bohn et al., 1995; Knight et al., 2002).

Beyond this expected association, frequent RSO drinkers (weekly or more) met an increased number of criteria for AUD compared with non-/rare RSO drinkers (monthly or less). Thus, there was an independent effect of RSOD. By adjusting for DV, it became clear that RSOD had an effect over and above it (Gmel et al., 2011).

Only a few studies have used a prospective design and adjusted for DV - the results of this study were in accordance with these studies (Bonomo et al., 2004; Dawson et al., 2008; Viner and Taylor, 2007).

Moreover, we observed a combined effect of DV and RSOD, tested with the interaction term. In both cross-sectional and longitudinal associations, the interaction term was negative. This meant that the DV was more strongly associated with AUD among non-/rare RSO drinkers than among frequent RSO drinkers. Therefore, the amount of alcohol drunk seems less important than pattern of drinking.

This study had some limitations. To begin with, the design only included men. Studies including women are needed in order to assess possible differences between women and men. Another shortcoming concerned the RSOD operationalization. Indeed, the use of an ordinal scale with a cut-off of six drinks or more on a single occasion may result in loss of variability. Since patterns of alcohol use appear to be important for investigating AUD and other health and social outcomes, efforts should be made to design a more precise and reliable measure of RSOD, including, for example, duration of drinking episode and number of drinks. Another limitation was related to assessment of the alcohol use variable. Young inexperienced users might have misinterpreted questions about AUD. For example, participants who mentioned tolerance as a criterion for their alcohol use may have become more experienced with time, which would suggest that their answer may not provide a reliable dependence criterion. Additionally, participants may have not really known exact quantities of alcohol they consumed, especially heavy drinkers. Finally, one must note that, despite using a prospective design, evaluating causal relationships is difficult. Therefore, the conclusions drawn from this study should be interpreted cautiously.

5. Conclusion

To summarize, RSOD appears to be a harmful pattern of drinking, for both concurrent and subsequent AUD. RSOD had an association independent of DV, with an increased number of criteria for AUD among frequent RSO drinkers. Furthermore, RSOD had a combined effect with DV; specifically, being a frequent RSO drinker or a non-/rare RSO drinker moderated the relationship between DV and AUD. This result highlights the importance of taking drinking patterns into account. Further studies investigating the relationship between alcohol use and AUD should include drinking patterns together with DV in their models. Public health planning such as preventive actions, treatment planning, and interventions, should also add a focus on alcohol use patterns. Indeed, RSO drinkers constitute a vulnerable subgroup for AUD.

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Table 1. Descriptive statistics of alcohol use

	Baseline	Follow-up
Frequent RSOD[1]	24.7 (1,104)	22.9 (1,022)
Drinking volume (no. drink per week)[2]	5.67 (9.85)	5.85 (10.48)
Alcohol use disorder (0-11)[3]	1.38 (1.76)	1.35 (1.66)

RSOD, risky single-occasion drinking (frequent RSOD: weekly or more, rare RSOD: monthly or less).

[1] Percentage (N)

[2] Median (interquartile range)

[3] Mean (standard deviation)

Table 2. Beta parameters for cross-sectional and longitudinal generalized linear models of alcohol use disorder on RSOD, volume of alcohol use, and their interaction.

		Alcohol use disorder	
		Baseline	Follow-up
Cross-sectional associations	RSOD	1.002***	0.972***
	Drinking volume	0.069***	0.068***
	Interaction RSOD/volume alc.	-0.052***	-0.049***
Longitudinal associations	RSOD	-	0.343**
	Drinking volume	-	0.013**
	Interaction RSOD/volume alc.	-	-0.027***

RSOD, risky single-occasion drinking (frequent RSOD coded 1: weekly or more, rare RSOD coded 0: monthly or less).

* $p < .05$, ** $p < .01$, *** $p < .001$.

Generalized linear models for count outcomes (negative binomial regressions) were performed, controlling for age, language, level of education, perceived family income, and age at first alcohol use. Number of alcohol use disorder criteria at baseline, drinking volume at follow-up, and RSOD at follow-up were also controlled for in the longitudinal models.

Figure 1. Interaction between drinking volume and risky single-occasion drinking for the number of criteria for alcohol use disorder (baseline)