

Alcohol use and personality trait change: pooled analysis of six cohort studies

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Abstract

Background: Personality has been associated with alcohol use, but less is known about how alcohol use may influence long-term personality trait change.

Methods: Present study examines associations between alcohol use and change in the five major personality traits across two measurement occasions (mean follow-up of 5.6 years). A total of 39 722 participants (54% women) were pooled from six cohort studies for an individual-participant meta-analysis. Alcohol use was measured as (1) average alcohol consumption, (2) frequency of binge drinking, (3) symptoms of alcohol use disorder, and (4) a global indicator of risky alcohol use. Change in the five major personality traits (extraversion, emotional stability, agreeableness, conscientiousness and openness to experience) were used as outcomes.

Results: Risky alcohol use was associated with increasing extraversion (0.25 T-scores; 95% Confidence Interval[CI] 0.07 to 0.44) and decreasing emotional stability (-0.28; 95% CI -.48 to -0.08), agreeableness (-0.67; 95% CI -0.87 to -0.36) and conscientiousness (-0.58; 95% CI -0.79 to -0.38). Except the association between alcohol use and extraversion, these associations were consistent across cohort studies and across different measures of alcohol use.

Conclusions: These findings suggest that alcohol use is associated with personality trait changes in adulthood.

Keywords: personality; Big Five; alcohol use; meta-analyses; longitudinal studies

Alcohol consumption is recognized as a major public health problem (World Health Organization 2014), high alcohol consumption being an important risk factor for chronic diseases, disability and early mortality (Rehm *et al.* 2009; Roerecke & Rehm 2013). Alcohol use disorders are fairly common mental disorders; for example, it has been estimated that the 12 month prevalence of alcohol use disorder is around 14 % in the United States (Grant *et al.* 2015). Psychological consequences of alcohol use have also been demonstrated in studies where long term alcohol use has been associated with aggressive behavior in close relationships (Bushman & Cooper 1990), impaired emotional processing (Maurage *et al.* 2011; Kornreich *et al.* 2013), and poor mental health (Boden & Fergusson 2011). However, it remains unclear whether alcohol use has broader psychological implications in terms of personality trait change. In the current study, we examined whether three different measures of alcohol use are associated with changes in the five major personality traits.

Personality traits and alcohol consumption

The five major personality traits (i.e., Big Five; extraversion, emotional stability, agreeableness, conscientiousness and openness) describe individual differences in stable patterns of feelings, thoughts and behaviors. Although absolute stability of personality traits between individuals is relatively high (Roberts & DelVecchio 2000), personality traits are subject to change. Important normative changes in personality traits have been well established, i.e., emotional stability, agreeableness, and conscientiousness have been found to increase (Roberts *et al.* 2006).

From the numerous studies that have examined the association between the five major personality traits and alcohol use, cross-sectional meta-analyses have shown higher alcohol consumption among individuals with high neuroticism, low agreeableness, and low

conscientiousness (Bogg & Roberts 2004; Malouff *et al.* 2007). Similarly, individuals with alcohol-related substance disorder appear to have higher levels of neuroticism and lower levels of conscientiousness when compared to control participants in cross-sectional meta-analysis (Kotov *et al.* 2010). Individual longitudinal studies have provided similar evidence; higher extraversion, higher neuroticism, and lower agreeableness have been associated with future alcohol problems in the Midlife in the United States (MIDUS) study (Turiano *et al.* 2012), and high neuroticism has been associated with increased problematic alcohol use among young adults in a twin study (Hicks *et al.* 2012).

In an individual-participant meta-analysis of over 70 000 participants from eight cohort studies, higher extraversion and lower conscientiousness were associated with increased risk of transitioning from moderate to heavy alcohol consumption over time whereas higher neuroticism and lower agreeableness were associated with heavy alcohol consumption only cross-sectionally (Hakulinen *et al.* 2015a). Alcohol abstinence was associated with lower extraversion, higher neuroticism, higher agreeableness and lower openness. Except for neuroticism, these associations were replicated in longitudinal analysis of transitioning from moderate consumption to abstinence (Hakulinen *et al.* 2015a).

Contrary to the numerous studies examining the association between personality traits with alcohol use, limited number of studies have examined alcohol use as a contributor to personality trait change over the life course. Moreover, most of these studies have concentrated on neuroticism or more specific personality constructs such as impulsivity. High alcohol consumption has been associated with increasing novelty seeking, sensation seeking and impulsivity in college samples (Quinn *et al.* 2011; Littlefield *et al.* 2012). In the Minnesota Twin Family Study, young adults who had an alcohol use disorder over two time points had lower

normative decline in neuroticism (Hicks *et al.* 2012). Similarly, decrease in alcohol-related problems was found to co-vary with decrease in neuroticism and increase in conscientiousness in small sample college students who were followed over 16 years (Littlefield *et al.* 2009, 2010). In a sample of 2245 college students, quitting binge drinking was associated with a normative decline in neuroticism (Ashenhurst *et al.* 2015). In a recent study by Allen, Vella and Laborde (2015) using a nationally representative sample of over 10 000 Australian adults, alcohol consumption was not associated with mean level personality trait change. However, increase in alcohol consumption was associated with increase in neuroticism (Allen *et al.* 2015), indicating that changes in alcohol consumption could lead to changes in personality traits. Taken together, there is evidence that alcohol use at least in early adulthood is associated with changes in personality traits. However, the evidence is scarce and there is a lack of large scale studies on the topic. Moreover, it is also not known whether changes shown by previous studies can be found after adolescence and young adulthood when personality traits are more stable (Roberts *et al.* 2006).

Present study

The present study examines whether alcohol use is associated with changes in Big Five personality traits using data from six longitudinal cohort studies with over 39 000 participants. We pooled these studies for an individual-participant meta-analysis, which provided us high statistical power and allowed us to examine how similar the results were across individual studies. We used three common measures of alcohol use: average alcohol consumption based on units of alcohol consumed, frequency of binge drinking, and alcohol-related problems. In addition to these measures, we also examined whether a global indicator of risky alcohol use was

associated with personality trait change. This enabled us to identify those individuals who had a risky alcohol use in any of the three measures we used. We examined first study-specific associations, which were then pooled using individual-participant meta-analysis.

Methods

Following the approach of previous personality-health individual participant meta-analytic studies (Jokela *et al.* 2013a, 2013b), we searched two international data archives, ICPSR (<http://www.icpsr.umich.edu/icpsrweb/ICPSR>) and UK Data Service (<http://ukdataservice.ac.uk/>), to identify potential large-scale cohort studies that contain repeated measures of alcohol consumption and personality traits. We used the following criteria for inclusion: (A) studies needed to be open access, (B) had information on participant's alcohol consumption, alcohol related problems or binge drinking, (C) had a fairly large sample size ($n > 1000$), and (D) personality traits measured twice with the brief 15-item or more comprehensive personality trait questionnaire based on the Five-Factor Model of personality. The following six cohort studies met these criteria: the German Socio-Economic Panel Study (GSOEP), the Household, Income and Labour Dynamics in Australia (HILDA) Survey, the Health and Retirement Study (HRS), the Midlife in the United States (MIDUS), the Wisconsin Longitudinal Study graduate (WLSG) sample, and the Wisconsin Longitudinal Study sibling (WLSS) sample. These studies and measures are described in detail in the **online supplement appendix**.

In short, GSOEP began in 1984 and it is a longitudinal survey of private households (Wagner *et al.* 2007). The original sample included 5921 households and 12,245 individual respondents. HILDA is a household-based panel study which began in 2001 including a large

national probability sample of Australian households occupying private dwellings (n=7,682 households with 19,914 individuals at baseline) (Wooden & Watson 2007). HRS is a nationally representative longitudinal study that began in 1992 and it includes more than 30000 individuals representing the US population older than 50 years (Juster & Suzman 1995). MIDUS is based on a nationally representative random-digit-dial sample of 7108 English-speaking adults who were between 25 to 74 years old in 1995-1996 (Brim *et al.* 2011). The Wisconsin Longitudinal Study (WLSG) consists of 10317 randomly selected participants who were born between 1937 and 1940 and who graduated from Wisconsin high schools in 1957 (Herd *et al.* 2014). In addition to the main graduate sample, data has been collected on a selected sibling of a sample of the graduates (WLSS). Although the data collection in adulthood has been very similar between graduate and sibling samples, in the current study, graduate and sibling samples were treated separately as the sibling sample is more heterogeneous in terms of age.

Measures

The following standardized questionnaire instruments were used to assess five major personality traits (extraversion, neuroticism, agreeableness, conscientiousness, and openness to experience): 15-item version of the Big Five Inventory (BFI) was used in GSOEP (John *et al.*, 1991; John *et al.*, 2008); 36-item inventory based on the Saucier's and Goldberg's Big Five Markers Scale was used in HILDA (Saucier, 1994); 25-item questionnaire was used in HRS and MIDUS (Lachman and Weaver, 1997); and 29-item version of the BFI was used in WLSG and WLSS (John *et al.*, 1991; John *et al.*, 2008). Although some of these instruments are rather short, different instruments measuring the Big Five personality traits have considerable convergent validity (John *et al.* 2008), indicating good reliability across personality traits measures.

Three different measures of alcohol use were slightly differently available across included cohort studies. Heavy alcohol consumption was measured in units of consumed alcohol and defined as follows: men – more than 14 units per week; women – more than 7 units per week. However, there were two exceptions, in GSOEP participants were asked how often they drank beer, wine, spirits, and mixed drinks, which were self-reported using a four-point scale (0=Never, 1=Seldom, 2=Once in a while, 3=Regularly) and heavy alcohol consumption was defined as score of 7 or more on the summed score of these four questions. In the MIDUS baseline, participants reported how many times during the past 12 months they had used much larger amounts of alcohol than they intended to or had used them for a longer period of time than then intended to. Participants who answered 3 to 5 times or more during the past 12 months were defined as heavy alcohol consumers. In MIDUS follow-up, WLSG and WLSS a participant was defined as binge drinker if he/she consumed more than 5 units of alcohol on the same occasion during last month, whereas in HRS a cut-off of more than 4 units during last 3 months was used. Data on binge drinking was not available in HILDA, MIDUS baseline and GSOEP. Alcohol related problems were defined according to the criteria of the Alcohol Use Disorders Identification Test (AUDIT) (Babor *et al.* 2001). Participant was defined as having alcohol problem if he/she had at least one AUDIT symptom (e.g., felt bad or guilty about drinking, felt need to cut down drinking, drinking caused problems at work). Data on alcohol related problems was not available from HILDA and GSOEP. To identify those individuals who had a risky alcohol consumption in any of the three measures, we created also a global indicator of risky alcohol consumption, which was defined as the absence versus presence of any of the 3 indicators.

Other measures included sex, age, and race/ethnicity (0=white, non-Hispanic; 1=other),

and these measured were acquired from self-reported questionnaires and face-to-face interviews.

Statistical analysis

Change in personality traits was examined by predicting personality trait score at T2 by alcohol use at T1, adjusting for personality trait score at T1, age, sex, race/ethnicity, and the length of follow-up time in months between T1 and T2. Heavy alcohol consumption, binge drinking, alcohol problems, and risky alcohol use were used as predictors in separate models. In addition, to examine robustness of the findings also risky alcohol use at T2 was used as a predictor in a separate model. For easier interpretation of effect sizes, personality traits were first transformed into T-scores (Mean=50, standard deviation=10) by using means and standard deviations at T1 as the reference to which personality scores at both T1 and T2 were standardized.

To compare and quantify the obtained effects sizes in more detail, we examined how large the personality trait change associated with alcohol use was in relation to the average change in personality traits over time. The average changes in the personality traits were estimated by pooling the study-specific personality trait change scores in separate meta-analyses. For this analysis, linear personality trait change was assumed, and only participants 50 years or older were included to avoid non-linear changes in personality traits, which have been shown to occur at younger ages and on longer follow-up periods (Roberts *et al.* 2006). Differences in follow-up times between studies were taken into account by assuming a linear association between years of follow-up and degree of personality trait change. Thus, before carrying out the meta-analysis, in each study we divided the raw change scores by follow-up time (in years) and multiplied this by 5 to give an estimate of average personality trait change per 5 years of age.

This allowed us to compare normative personality trait change with effect sizes in the associations between alcohol use and personality trait change.

Analyses were first performed in each study separately and then the obtained estimates were pooled together. Due to small number of included studies, instead of using random-effects meta-analysis, fixed-effect meta-analysis was used. Heterogeneity in the effect sizes was examined using the I^2 estimates. Statistical analyses were performed using Stata, version 13.1, and *metan* command package was used for conducting meta-analyses.

Results

Descriptive characteristics of the study participants are shown in **Table 1**. In total, current study included 39 772 (54% women) participants with a mean age of 51.5 years and a mean-follow up time of 5.6 years. The percentage of individuals classified as heavy alcohol consumers at the baseline (T1) ranged from 8% in HRS to 21% in GSOEP.

Associations between baseline heavy alcohol consumption, alcohol problems and binge drinking with personality trait changes are presented in **Figure 1** (for cohort-specific associations, please see **Online Supplementary Figures 1-3**). Except for no association between heavy alcohol consumption and emotional stability, heavy alcohol consumption, having alcohol problems and binge drinking were associated with decreasing emotional stability, agreeableness and conscientiousness. There was significant heterogeneity across studies in the association between heavy alcohol consumption and decreasing conscientiousness ($I^2=76%$, $p=0.001$), but not in the other associations. Heavy alcohol consumption was also associated with increasing extraversion and binge drinking was associated with decreasing openness. However, there was

considerable heterogeneity in both associations (heavy alcohol consumption and extraversion [$I^2=77%$, $p=0.001$]; binge drinking and openness [$I^2=78%$, $p=0.01$]).

Associations between baseline risky alcohol use and risky alcohol use at follow-up with personality trait change are shown in **Figure 2** (cohort-specific associations are presented in **Online Supplementary Figures 4-5**). Baseline risky alcohol use was associated with increasing extraversion (0.25 T-scores; 95% Confidence Interval[CI] 0.07 to 0.44) and with decreasing emotional stability (-0.28; 95% CI -0.48 to -0.08), agreeableness (-0.67; 95% CI -0.87 to -0.36) and conscientiousness (-0.58; 95% CI -0.79 to -0.38). Similarly, risky alcohol use at the follow-up was associated with increasing extraversion (0.43; 95% CI 0.15 to 0.71) and with decreasing emotional stability (-0.61; 95% CI -0.90 to -0.31), agreeableness (-0.40; 95% CI -0.71 to -0.09) and conscientiousness (-0.67; 95% CI -0.98 to -0.36).

Change from risky alcohol use to non-risky alcohol use over the follow-up was associated with decreasing extraversion (-0.36; 95% CI -0.69 to -0.02) and with increasing agreeableness (0.51; 95% CI 0.14 to 0.88) and conscientiousness (0.38; 95% CI 0.01 to 0.75) (cohort-specific associations are presented in **Online Supplementary Figure 6**). No association between change from risky to non-risky alcohol use with changes in emotional stability was found. No substantial heterogeneity in the estimates were found.

Analyses examining average personality trait change among participants aged 50 years or older showed that extraversion decreased (-0.42 per 5-year increase in age; 95% CI -0.50 to -0.34), emotional stability increased (0.91; 95% CI 0.83 to 1.00), agreeableness remained stable (-0.04; 95% CI -0.13 to 0.06), conscientiousness decreased (-0.52; 95% CI -0.62 to -0.42) and openness to experience decreased (-0.64; 95% CI -0.72 to -0.56) over the follow-up (cohort-specific results are shown in **Online Supplementary Figure 6**). Thus, risky alcohol use at baseline reversed the

average age-related personality trait change by 3 years in extraversion [$= (0.25 / -0.42) \times 5 = -3$] and 1.5 years in emotional stability. In addition, risky alcohol use at baseline accelerated the age-related decline in conscientiousness by 5.6 years. Around similar effect sizes were observed between risky alcohol use at follow-up and average personality trait change.

DISCUSSION

The present pooled analysis of six prospective cohort studies examined whether alcohol use is associated with personality trait change assessed over several years of follow-up. Results showed that alcohol use was associated with increasing extraversion and decreasing emotional stability, agreeableness, and conscientiousness. Except the association between alcohol use and extraversion, these results were robust across studies from different countries and across different measures of alcohol use. These findings suggest that alcohol use is associated with personality trait change.

A number of biological, psychological and social mechanisms could explain the present findings. It is well known that heavy alcohol consumption impairs mental health (Boden & Fergusson 2011). Personality trait emotional stability and mental health problems have a strong association (Kotov *et al.* 2010; Hakulinen *et al.* 2015b), which could explain why high alcohol consumption predicts decrease in emotional stability. Moreover, long term alcohol use has been associated with impaired emotional recognition and decoding (Maurage *et al.* 2011; Kornreich *et al.* 2013), which could also explain how alcohol consumption contributes to decrease in emotional stability.

Association between alcohol use with a number of aggressive reactions and conflicts in relationships is well established (Bushman & Cooper 1990; Foran & O'Leary 2008). These

findings could in part explain why risky alcohol use was associated with decreasing agreeableness in the current study. It is, for example, possible that risky alcohol use leads to problems in social relationship, which in turn result in decrease in the number of social relationships. Moreover, alcohol use can impair executive functions (e.g., impair executive behavioural control and disinhibit impulsive responding) leading to poor control of cognitive behaviour (Heinz *et al.* 2011), which in turn can increase aggressive behaviour.

Alcohol use has been associated with poorer decision making and with impairments especially in the goal-directed decision making (Sebold *et al.* 2014). In addition, as alcohol begins to impair executive control, explicit cognitive processes start to diminish and implicit impulsive processes dominate (Wiers & Stacy 2006). These effects could also be seen as lowering conscientiousness. From the Five Factor personality traits, low conscientiousness has been most systematically associated with poor health outcomes, such as obesity (Jokela *et al.* 2013b) and onset of diabetes (Jokela *et al.* 2014a), and poor health behaviors (Bogg & Roberts 2004; Hakulinen *et al.* 2015a, 2015c; Wilson & Dishman 2015; Sutin *et al.* 2016). Moreover, low conscientiousness has also been associated with higher risk of early mortality (Jokela *et al.* 2013a). Thus, long term alcohol use could potentially lead to lower conscientiousness that in turn could contribute to development of chronic diseases

Regarding extraversion, in the current study, only heavy alcohol consumption – but not binge drinking or alcohol related problems – was associated with increasing extraversion. This finding may be related to a difference between heavy alcohol consumption associated with social drinking but not with problem-related drinking. In addition, drinking has been found to lift up mood among highly extraverted individuals (Fairbairn *et al.* 2015), which could partly explain the current finding.

Our findings are in line with the previous studies where high alcohol consumption have been associated with decrease in emotional stability (Littlefield *et al.* 2009, 2010; Hicks *et al.* 2012; Ashenhurst *et al.* 2015). Many of the previous studies on the topic have been conducted on college students (Littlefield *et al.* 2009, 2010, 2012; Quinn *et al.* 2011), which might explain some differences in findings between current and previous studies. However, current results are in line with studies where low emotional stability, low agreeableness and low conscientiousness has been associated with current and future high alcohol consumption (Bogg & Roberts 2004; Malouff *et al.* 2007; Hakulinen *et al.* 2015a). In addition, current findings highlight the possibility that alcohol use and personality traits could form a vicious cycle where personality traits lead to increase in alcohol use that in turns contributes to harmful personality change. Recently, this kind of co-development from early adolescence to early adulthood has been demonstrated in a study using the Minnesota Twin Family Study data (Durbin & Hicks 2014).

In terms of effect sizes, heavy alcohol consumption and binge drinking had a rather modest effect on personality trait change (around 0.5 T-score units that corresponds to 0.05 standard deviations), whereas the effect size for alcohol problems was slightly higher for alcohol related problems in the change of agreeableness and conscientiousness (around 1 T-score units that corresponds to 0.1 standard deviations). However, these effect sizes were similar when compared to the average change of personality traits per five years. Moreover, the effect sizes were higher than the effect of an increase of depressive symptoms on neuroticism (Hakulinen *et al.* 2015b), but similar than the effect of onset of a single chronic disease on personality traits (Jokela *et al.* 2014b). Thus, effect of alcohol use on personality trait change seems to comparable to previously reported predictors of personality trait change. When compared to the average age-related personality change, risky alcohol use attenuated the normative personality change by 3

years in extraversion and 1.5 years in emotional stability. Moreover, risky alcohol use accelerated the normative age-related decline in conscientiousness by 5.6 years. This highlights how risky alcohol use can accelerate or decelerate normative personality trait change after middle age to one way or another.

Strengths and limitations

Strengths of the current study include prospective data from six cohort studies and three different measures of alcohol use. Present study has also some limitations. Participants were mainly white and middle-aged adults, and thus results might not be generalizable to younger participants or to other ethnic groups. Alcohol use was self-reported, which has been associated with under-reporting of alcohol use (Stockwell *et al.* 2014). It is also not known whether personality traits influence the accuracy and truthfulness of alcohol use self-reports. Moreover, alcohol use was measured slightly differently across studies, which could lead to misclassification of alcohol use and introduce heterogeneity in the associations. Although personality traits were measured with different instruments, it has been shown that the Big Five personality trait measures have considerable convergent validity (John *et al.* 2008), suggesting that different measures of personality traits are unlikely source of major heterogeneity.

There are also number of factors that could confound current results. Negative life events such as job loss have been associated with alcohol consumption and personality trait change (Boyce *et al.* 2015; de Goeij *et al.* 2015), and thus they could potentially lead to both increase in alcohol consumption and personality trait change. Low socioeconomic positioning over the life course could also explain the increased alcohol consumption and low conscientiousness in adulthood (Collins 2016; Sutin *et al.* 2017). Our finding that a change from risky alcohol use to

non-risky alcohol use over the follow-up was associated with increasing agreeableness and conscientiousness, suggests that associations between alcohol risky use and personality trait change are also reversible.

Conclusion

To conclude, present study using data from six prospective cohort studies suggests alcohol use is associated with increasing extraversion and decreasing emotional stability, agreeableness, and conscientiousness. These findings suggest that alcohol use is associated with personality trait change after middle age.

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by the University of Wisconsin Survey Center. A public use file of data from the Wisconsin Longitudinal Study is available from the Wisconsin Longitudinal Study, University of Wisconsin-Madison, 1180 Observatory Drive, Madison, Wisconsin 53706 and at <http://www.ssc.wisc.edu/wlsresearch/data/>. The opinions expressed herein are those of the authors.

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Table 1. Descriptive characteristics of the study participants in the included cohort studies

| | GSOEP | HILDA | HRS | MIDUS | WLSG | WLSS |
|--|---------------|--------------|--------------|--------------|---------------|---------------|
| Number of participants | 13658 | 8326 | 7773 | 3813 | 3603 | 2599 |
| Age in years at T1, mean (sd) | 47.4 (16.6) | 44.3 (17.0) | 67.0 (9.6) | 47.2 (12.4) | 53.7 (0.7) | 52.7 (7.0) |
| Follow-up time in months, mean (sd) | 48.1 (1.6) | 47.9 (1.2) | 50.6 (3.7) | 107.2 (6.2) | 133.9 (4.0) | 135.8 (6.9) |
| Sex, % (n) | | | | | | |
| Men | 47.6 (6,501) | 45.8 (3,816) | 41.3 (3,171) | 44.5 (1,695) | 47.4 (1,708) | 45.2 (1,176) |
| Women | 52.4 (7,157) | 54.2 (4,510) | 58.7 (4,508) | 55.5 (2,118) | 52.6 (1,895) | 54.8 (1,423) |
| Nationality / ethnicity | | | | | | |
| Majority | 94.1 (12,851) | 79.2 (6,598) | 80.4 (6,250) | 92.9 (3,543) | 100.0 (3,603) | 100.0 (2,599) |
| Minority | 5.9 (807) | 20.8 (1,728) | 19.6 (1,523) | 7.1 (270) | - | - |
| Measures of alcohol consumption | | | | | | |
| Heavy alcohol consumption at T1, % (n) | | | | | | |
| No | 84.1 (11,493) | 78.9 (6,570) | 92.2 (7,074) | 91.9 (3,503) | 87.9 (2,879) | 92.6 (2,402) |
| Yes | 15.9 (2,165) | 21.1 (1,756) | 7.8 (601) | 8.1 (309) | 12.1 (395) | 7.4 (191) |
| Heavy alcohol consumption at T2, % (n) | | | | | | |
| No | 84.1 (10,207) | 78.5 (6,442) | 92.1 (6,272) | 93.7 (3,321) | 83.6 (2,299) | 89.3 (2,149) |
| Yes | 15.9 (1,930) | 21.5 (1,767) | 7.9 (541) | 6.3 (225) | 16.4 (451) | 10.7 (258) |
| Binge-drinker at T1, % (n) | | | | | | |
| No | - | - | 86.1 (6,673) | - | 75.7 (2,134) | 77.3 (1,064) |
| Yes | - | - | 13.9 (1,075) | - | 24.3 (684) | 22.7 (313) |
| Binge-drinker at T2, % (n) | | | | | | |
| No | - | - | 86.7 (5,971) | 87.2 (3,092) | 82.6 (1,983) | 84.6 (1,330) |
| Yes | - | - | 13.3 (914) | 12.8 (455) | 17.4 (418) | 15.4 (242) |
| Alcohol problems at T1, % (n) | | | | | | |
| No | - | - | - | 87.0 (3,319) | 69.2 (2,495) | 73.5 (1,535) |
| Yes | - | - | - | 13.0 (494) | 30.8 (1,108) | 26.5 (554) |
| Alcohol problems at T2, % (n) | | | | | | |
| No | - | - | - | 95.7 (3,650) | 71.0 (2,434) | 73.0 (1,392) |
| Yes | - | - | - | 4.3 (163) | 29.0 (996) | 27.0 (514) |
| Risky alcohol use at T1, % (n) | | | | | | |
| No | 84.1 (11,493) | 78.9 (6,570) | 83.7 (6,505) | 84.9 (3,237) | 53.3 (1,919) | 69.6 (1,808) |
| Yes | 15.9 (2,165) | 21.1 (1,756) | 16.3 (1,268) | 15.1 (576) | 46.7 (1,684) | 30.4 (791) |
| Risky alcohol use at T2, % (n) | | | | | | |
| No | 84.1 (10,207) | 78.5 (6,442) | 84.0 (5,791) | 83.3 (2,955) | 52.1 (1,579) | 66.4 (1,598) |

| Yes | 15.9 (1,930) | 21.5 (1,767) | 16.0 (1,106) | 16.7 (593) | 47.9 (1,452) | 33.6 (809) |
|-----|--------------|--------------|--------------|------------|--------------|------------|
|-----|--------------|--------------|--------------|------------|--------------|------------|

Note. Due to missing data in covariate variables, numbers of covariate frequencies may not add up to the total number of participants with personality and baseline alcohol consumption data. GSOEP, German Socio-Economic Panel Study; HILDA, Household, Income and Labour Dynamics in Australia; HRS, Health and Retirement Study; MIDUS, Midlife in the United States; WLSG, Wisconsin Longitudinal Study Graduate Sample; WLSS, Wisconsin Longitudinal Study Sibling Sample; T1, baseline; T2, follow-up, sd, standard deviation.

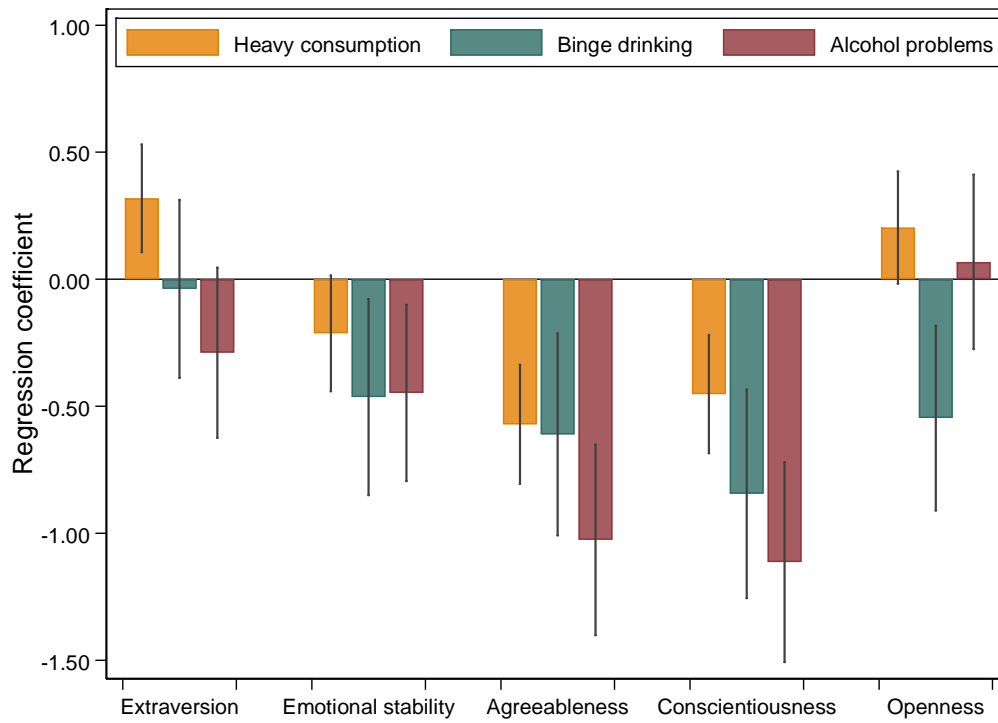
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Figure 1. The associations between heavy alcohol consumption, binge drinking and alcohol problems with change in personality traits

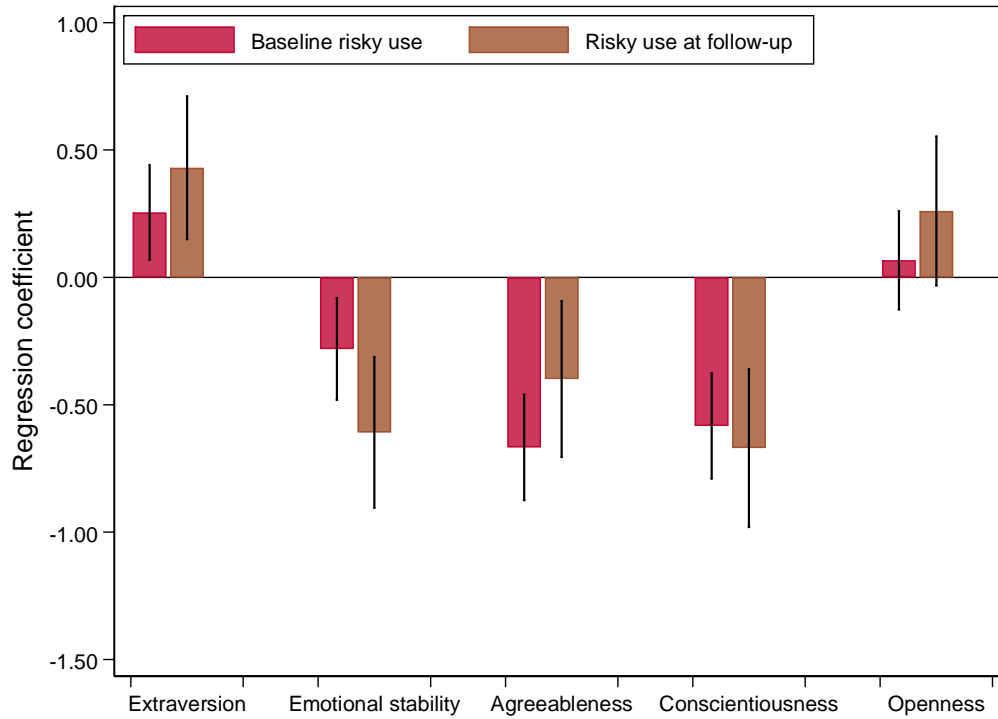


Figure 2. The associations between any risky alcohol use at the baseline and at the follow-up with the change in personality traits