# When alcohol fills the gap: Basic psychological need satisfaction and frustration predict drinking patterns

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Abstract

**Objective:** Test whether perceived basic psychological need satisfaction from alcohol interacts with basic psychological need frustration to predict hazardous/harmful drinking consistent with self-determination theory's need density hypothesis. **Method:** Study 1 was a cross-sectional study (742 U.S. adults) that showed effects of perceived need satisfaction from alcohol and general need frustration on hazardous/harmful drinking (AUDIT). Study 2 was a preregistered 5-day diary study (baseline and four daily surveys; n = 786, 3,358 observations) that assessed effects of daily need frustration and baseline need satisfaction from alcohol on drinking. **Results:** Across studies, perceiving alcohol as need-satisfying predicted more hazardous/harmful drinking and greater consumption. In Study 1, the association between need-satisfying alcohol use and AUDIT scores was stronger among individuals with greater general need frustration. In Study 2, need satisfaction from alcohol predicted higher odds of any drinking (OR = 1.23 [95% CI 1.06, 1.42]) and increased rate (IRR = 1.21 [95% CI 1.12, 1.31]) of daily drinking. We did not find a clear interaction between daily need-frustration and need satisfaction from alcohol. **Conclusions:** People who find alcohol need-satisfying drink more, especially when they have chronic basic psychological need frustration. Day-to-day fluctuations in need frustration had limited influence. If findings are confirmed in experimental studies, interventions that reduce persistent need frustration, or that help meet basic psychological needs in healthier ways may reduce alcohol consumption.

*Keywords:* alcohol, Self-Determination Theory, basic psychological needs, need density hypothesis, hazardous drinking, need frustration

Word count: 7,069

**Public Health Significance Statement.** These studies show people who report higher basic psychological needs satisfaction when drinking alcohol engage in more hazardous/harmful drinking, especially if those needs are chronically frustrated. Addressing chronic basic psychological need frustration, or promoting healthier ways of meeting frustrated needs may reduce drinking harms.

# When alcohol fills the gap: Basic psychological need satisfaction and frustration predict drinking patterns

Alcohol consumption is a global public health problem despite well-documented harms. In 2019, 2.6 million of all deaths worldwide were attributable to alcohol consumption, accounting for 4.7% of all deaths (World Health Organization, 2024). Alcohol also contributes to chronic disease, poorer mental and physical health, and wide-ranging social problems, including family violence (World Health Organization, 2024). Alcohol causes harms over short and long spans of time. Acute intoxication leads to injuries to the individual and others (World Health Organization, 2024). Sustained heavy drinking also accumulates biological harms, including to the liver, cardiovascular system, and brain, as well as systemically which leads to increased risk of cancers (National Institute on Alcohol Abuse and Alcoholism, 2025). Given these well-established harms, why do so many people continue to drink at levels that increase risk, and what can be done to reduce harmful consumption?

While alcohol can be used as a coping mechanism (Cox & Klinger, 1988), in most cases people drink for other reasons (D'Aquino et al., 2023; Kuntsche et al., 2005). Most research into drinking motivation has focused on self-reported explicit reasons for drinking. Among young people, these have included enhancement, social, coping, and conformity motives (Kuntsche et al., 2005). Analyses of adults' drinking motives identified a similar set, except conformity was replaced by confidence, and taste was separately motivating alongside enhancement motives (D'Aquino et al., 2023). These stated reasons for drinking are highly predictive of drinking behaviors (D'Aquino et al., 2023; Kuntsche et al., 2005). But what are the deeper motivational processes that shape these behaviors and preferences? Applying macro theories of motivation to alcohol consumption, such as *self-determination theory*, may provide a useful framework that helps generate new hypotheses (SDT; Ryan & Deci, 2017).

SDT is an influential theory of human behavior and personality development. Central to SDT is the understanding that motivation varies not only in quantity, but in quality: in a

continuum from more controlled to more autonomous forms (Ryan & Deci, 2017). SDT has been shown to be relevant to many domains including psychology, education, health, and organizational research (Ntoumanis et al., 2021; Ryan & Deci, 2017). Research applying SDT to substance use is growing, and has primarily drawn from three of SDT's six mini-theories (Herchenroeder et al., 2024). Work using *Causality Orientations Theory* has linked more controlled orientations to greater risk from drinking (Dukes et al., 2022). Research drawing on Organismic Integration Theory has shown motivation quality for drinking, and for drinking responsibly, is associated with drinking patterns and harm-reduction behavior, with more self-determined motivations tending to correlate with more adaptive outcomes and amotivation with greater risk (Courtney et al., 2025; Richards et al., 2022, 2023). Studies have also used *Basic Psychological Needs Theory* to show that need-related processes are implicated in both risky drinking and engagement in protective or harm-reduction behaviors, including motivations for responsible drinking and the use of protective behavioral strategies (Richards et al., 2020, 2022).

Basic Psychological Need Theory (BPNT) within SDT may be particularly relevant in understanding alcohol use because basic psychological needs are core drivers of motivation, well-being, and ill-being, and have already been shown to be relevant to addictive behavior in other domains (Rigby & Ryan, 2011). SDT posits three basic psychological needs: autonomy (feeling free and self-determined), competence (feeling effective), and relatedness (feeling connected to others). Satisfaction of these three needs universally supports autonomous motivation and well-being, whereas basic psychological need frustration causes more controlled forms of motivation, ill-being, and psychopathology (Ryan et al., 2022).

BPNT work has treated drinking as a consequence of general basic psychological need satisfaction or frustration. Broadly, satisfaction of basic psychological needs has been linked to safer drinking behaviors, and lower harms, while need frustration is linked to riskier alcohol use (e.g., Richards et al., 2026). For instance, those who feel controlled by parents (which frustrates basic psychological needs, Bradshaw et al., 2025; Zhao et al., 2019), or who

feel autonomy frustrated generally are more likely to drink alcohol. On the other hand, college students who are more need-satisfied drink fewer alcoholic drinks, and those who are need thwarted (e.g., after receiving poor grades) drink more (Burt et al., 2016). Among patients undergoing treatment for alcohol dependence, those with higher need satisfaction report weaker alcohol cravings and greater confidence in their ability to remain abstinent, whereas those experiencing competence frustration are at greatest risk of relapse (Tabiś & Poprawa, 2023).

These patterns are consistent with alcohol being used for need-compensation. This implies that alcohol may be experienced as need-satisfying in-the-moment. Drinking could be experienced as supporting autonomy through lowering inhibitions and facilitating choices; competence, by lowering awareness of weaknesses and increasing feelings of confidence; and relatedness by reducing social anxiety and facilitating social connection. However, there is little research exploring how drinking alcohol itself may be experienced as need-satisfying, thus motivating consumption. An exception is prior work with Aboriginal and Torres Strait Islander Australians ("Indigenous Australians"), where Conigrave et al. (2021) sought to explore experiences of need satisfaction while drinking alcohol. They found that Indigenous Australians tended to agree with statements suggesting alcohol satisfied their basic psychological needs and disagreed with statements suggesting that drinking frustrated those needs. Reporting alcohol as more need-satisfying was linked to greater consumption (Conigrave et al., 2021). This suggests that people can experience alcohol as need-satisfying while drinking, even if it causes harm over longer timeframes. If people drink (at least in part) in an attempt to satisfy basic psychological needs, what can be done to help them reduce consumption which harms their health?

Studies on video game and social media overuse may provide a potentially useful framework for exploring the dynamics of need satisfaction and need frustration in drinking behaviors. Rigby and Ryan (2011, 2017) proposed the *need density hypothesis*, in which finding something need-satisfying only poses a risk for game or internet overuse when

someone is experiencing high need frustration in general. It is the differential density of satisfactions that potentiates the problematic behaviors. This hypothesis has been explored in a number of studies. For example, Allen and Anderson (2018) investigated internet gaming disorder (IGD) and reported that, as predicted by the need density hypothesis, IGD scores increased as the satisfaction of needs in video games surpassed satisfaction of needs in the real world. Choi et al. (2025) reported that while need satisfactions were associated with adaptive game use, general need frustrations were more strongly associated with game addiction. They suggested that adolescents' game addiction mainly stems from need frustration arising from an "unsatisfactory reality" (page 1). Convergent results have also been found by Liu et al. (Liu et al., 2016) and Shen et al. (2013) regarding pathological internet use. Overall, the need density dynamic suggests that sustained problematic behaviors are more likely in people experiencing ongoing need frustration in their lives in general, who find an absorbing activity that at least in the short term provides need satisfactions (Ryan & Deci, 2017). Conigrave et al. (2021) previously speculated that the need density hypothesis might also be relevant to alcohol consumption. If so, this could offer insight into drinking motives informing clinical interventions and public health strategies. However, the need density hypothesis has not yet been tested in the context of alcohol consumption.

In this paper, we report preliminary tests of the need density hypothesis in relation to alcohol consumption across two studies. In Study 1, we examine a cross-sectional sample of adults to investigate whether need satisfaction from alcohol interacts with general psychological need frustration in predicting drinking behavior between-person. In Study 2, using a pre-registered diary design, we examine whether need satisfaction from alcohol and daily need frustration interact to longitudinally predict daily drinking. Together, these studies show how psychological need dynamics can play a role in shaping alcohol consumption.

### Hypotheses

**H1.** Need satisfaction from alcohol will be positively associated with more hazardous/harmful alcohol use.

**H2.** General need frustration will be positively associated with more hazardous/harmful alcohol use.

**H3.** The association between need satisfaction from alcohol and hazardous/harmful alcohol use will be moderated by general psychological need frustration, such that it is strongest among individuals high in need frustration.

**H4.** Baseline need satisfaction from alcohol will be positively associated with heavier daily drinking.

**H5.** The association between need satisfaction from alcohol and daily drinking will be moderated by daily psychological need frustration, such that need satisfaction from alcohol is more strongly associated with heavier drinking on days when need frustration is high.

## General Methods

### Reporting transparency

We report how we determined our sample size, all data exclusions, all manipulations, and all measures in the study. We used $\alpha = .05$ as our threshold for statistical significance. All analyses in both studies were conducted in R version 4.5.3 (2026-03-11) (R Core Team, 2025). For scale reliability analyses, we report McDonald's omega estimated using the omega function in the psych package (William Revelle, 2025). For measures with repeated observations, we report within- and between-person reliability estimated using the omegaSEM function in the multilevelTools package (Wiley, 2025). To prevent transcription errors, this manuscript was written in R Markdown using the 'papaja' package (Aust &

Barth, 2025). Analysis code can be found in the Study 2 pre-registration OSF project (https://osf.io/buj9c). Other materials for these studies are available by emailing the corresponding author.

### Adjustment for Age and Female Status

Age and female status were included as covariates in all Study 1 and Study 2 regression models (this did not change the pattern of results). Age was standardized ($z$), and female status was coded where female = 1, non-female = 0, then mean-centered; this means coefficients are adjusted for age and female status, while model intercepts represent outcomes expected at each sample's mean age and female status composition.

## Study 1

### Methods

**Design.** Study 1 tests Hypotheses 1–3 with a cross-sectional survey of U.S. adults recruited via Qualtrics. There was no experimental manipulation. Participants provided informed consent prior to participation. Procedures for Study 1 were approved by Australian Catholic University's Human Research Ethics Committee (2020-136E).

**Participants.** Participants were recruited by Qualtrics Panels in July 2021 and were a diverse sample of adults from the United States of America. Inclusion criteria were that participants were 21 years or older and had consumed alcohol in the past year. Participation rate cannot be determined as participants self-selected via Qualtrics. We used a convenience sampling strategy. As Study 1 was exploratory, sample size was determined by budget. Participant remuneration was determined and awarded by Qualtrics. Qualtrics monitored the response quality. In 158 cases, respondents were screened out by Qualtrics due to poor-quality responding and are not included in the analytic sample.

**Materials.**

***Demographics.*** Participants reported age (in years), sex (male, female, other), highest educational attainment, employment status, and ethnicity. Highest educational attainment was coded ordinally as: 'Some high school or less', 'Completed high school', 'Some college', 'Completed college / bachelor's degree', 'Some graduate / professional school', and 'Completed graduate / professional degree'. Employment status was recorded as 'Unemployed', 'Part-time', or 'Full-time'. Ethnicity options were: "White", "Black or African American", "American Indian or Alaska Native", "Asian", "Native Hawaiian" or "Pacific Islander" where participants could select more than one or enter their own into an "Other" response.

***Alcohol Use Disorders Identification Test (AUDIT).*** We measured hazardous/harmful alcohol consumption with the Alcohol Use Disorders Identification Test (AUDIT) (Saunders et al., 1993). AUDIT is a formative screening tool, widely used in research and clinical work to measure and screen for hazardous and harmful drinking (Saunders et al., 1993). Items such as "How often during the last year have you failed to do what was normally expected from you because of drinking?" are each scored on a 0–4 scale, except items 9 and 10 which are scored on a 0, 2, and 4 scale. AUDIT has a maximum possible score of 40. A score of 8 or more indicates hazardous drinking, and a score of 15 or more indicates possible dependence.

***Need Satisfaction from Alcohol Scale.*** The Need Satisfaction from Alcohol Scale measures the self-reported extent to which participants feel need satisfaction while drinking alcohol. This scale is based on the Alcohol Satisfaction of Psychological Needs scale originally developed for use with Indigenous Australians (Conigrave et al., 2021). Items were refined to remove reverse-scored items and to maintain a 9-item structure (i.e., three indexing each need). Example items include: "When I drink, I feel more able to be myself" (autonomy satisfaction), "Drinking makes me feel close to others" (relatedness satisfaction), and "When I drink, I feel like I'm good at things in general" (competence satisfaction); each responded to on a (1) 'Not at all true' to (6) 'Completely true' scale, such that higher scores

indicated greater levels of need satisfaction from alcohol. We used a 1-factor solution, taking the mean score across items ($\omega = 0.96$) (see supplementary materials for items and details of factor analysis, and a preliminary validation).

***Basic Psychological Needs Satisfaction and Frustration Scale.*** The basic psychological needs satisfaction and frustration scale (B. Chen et al., 2015) was used to measure the extent to which participants felt their basic psychological needs were satisfied or frustrated in general. We used mean scores for each of satisfaction ($\omega = 0.91$), and frustration ($\omega = 0.93$). Example items include: "I feel a sense of choice and freedom in the things I undertake" and "I feel excluded from the group I want to belong to." Responses were scored on a 6-point Likert scale from (1) "not at all true" to (6) "completely true".

***Attention check.*** We included a single attention check item in the middle of the survey: "This is an attention check question, please select option 5". The possible responses were "Not at all true for me" (1) through "Completely true for me" (5).

***Unused Instruments.*** Other questionnaires in the dataset which are not used here are: Satisfaction with Life Scale, Vitality and Depletion Scale, Perceived Locus of Causality, adapted to drinking context (Ryan & Connell, 1989), and Drinking Motives Questionnaire, Revised, Short-Form (Kuntsche & Kuntsche, 2009).

**Analysis.** Models were fit using the "stats" library (version 4.5.3). Effects were estimated using "ggeffects" version 2.3.2 (Lüdecke, 2018). We conducted hierarchical ordinary least squares regression analyses to predict AUDIT scores. Model 1 is an intercept-only model. In Model 2, we added the independent effect of need satisfaction from alcohol on AUDIT scores. In Model 3, we added the independent effect of general need frustration. In Model 4, we added an interaction effect between need satisfaction from alcohol and general need frustration. The statistical significance of each term is reported, along with the incremental increase in explained variance. As a sensitivity check, we repeated the analysis with AUDIT scores winsorized at the upper 1% of the distribution to

check that results were not driven by outliers (pattern and interpretation unchanged, see supplementary materials, Table S3). There were no missing data.

## Results

**Descriptive Statistics and Intercorrelations.** We removed 73 participants who failed the attention check from the analytic sample. There were 742 unique participants included in the analytic sample, with a mean age of 48.88 years (SD = 16.88). Approximately 49.50% identified as female. The majority identified as White (87.10%), followed by smaller proportions identifying as Black (5.80%), Asian (5.40%), American Indian/Alaska Native (1.30%), Native Hawaiian/Pacific Islander (0.90%), and Other (2%). Few participants reported having more than one ancestry (2.60%). Over half had completed college (61.86%). Just under half were unemployed (43.26%), while 44.88% were in full-time work, with the remainder employed part-time (11.86%).

Intercorrelations, means and standard deviations for Study 1 constructs are presented in Table 1. AUDIT scores positively correlated with need satisfaction from alcohol (supports H1), and general basic psychological needs frustration (supports H2). The link between AUDIT score and general basic psychological need satisfaction was not statistically significant. AUDIT scores tended to decrease with age in this sample and were lower for females.

**Predicting AUDIT scores.** The mean AUDIT score was 7.84 (SD = 8.15), slightly higher than typical AUDIT scores for non-clinical samples (M = 5.67, SD = 4.48; Y. Chen et al., 2024). Table 2 shows hierarchical regressions exploring predictors of AUDIT score. See Figure 1 for the predicted AUDIT by general need frustration and need satisfaction from alcohol (Model 4). Substantial variation was explained by adding need satisfaction from alcohol to the baseline model $\triangle R^2 = 14.94\%$ (Model 2, supports H1). Adding general need frustration to the model added a further $\triangle R^2 = 6.05\%$ of variance (Model 3, supports H2). Model 4 revealed a statistically significant interaction between need satisfaction from alcohol

and general need frustration. The interaction explains an additional 3.02% of variation over the main effects, and the predictions (Figure 1) demonstrate that the effect of need satisfaction from alcohol on AUDIT score is much stronger among those who are generally need frustrated (Model 4, supports H3).

Among those who find alcohol highly need-satisfying (+1 SD), those who also have high need frustration (+1 SD) on average had AUDIT scores that were in the possibly dependent (15+) range. Whereas those with low need frustration had low-risk mean AUDIT scores.

## Study 2

### Methods

**Design.** Study 2 is a within-subject repeated-measures survey design. There was no experimental manipulation. Study 2 primarily tests H4 and H5 and was pre-registered on the Open Science Framework (osf.io/buj9c) (Lavoie et al., 2023). Participants completed a baseline survey followed by four brief daily surveys on the first Tuesday, Thursday, Saturday, and Sunday after the baseline survey. Questions were answered in relation to the previous day (e.g., on Tuesday, participants answered questions about their experiences and behavior from Monday). Participants had 24 hours to complete each daily survey. Participants were invited to provide data at five timepoints (T0-T4). All Study 2 procedures were reviewed and approved by Australian Catholic University's Human Research Ethics Committee (2021-235E).

**Participants.** To be eligible, participants had to be 21 years or older, live in the United States of America, and consume at least one standard drink of alcohol per week. Participants were recruited from November 2023 to January 2024. Participants were recruited and paid via Prolific, but completed the surveys on the Qualtrics platform. Panel recruitment was performed by Prolific; we cannot estimate the participation rate as we do not have access to the number of participants who were invited to take part. Remuneration

increased across the five surveys: USD $2.00, $2.50, $3.00, $3.50, $4.00, with a $5.00 completion bonus (USD $20.00 total).

**Materials.** At baseline, we included the ten-item AUDIT and the same 9-item Need Satisfaction From Alcohol Scale ($\omega = 0.94$ in this baseline sample) that was used in Study 1.

We measured the following demographics: age, sex, highest educational attainment, employment status, and annual income. For the daily surveys, we collected measures of alcohol consumption using an adapted version of the second item of the AUDIT, "How many drinks containing alcohol did you drink yesterday?". Daily diary items were included in the Baseline survey. Participants could select from 0–20+ drinks. Participants were provided with a link to a visual guide to estimating standard drinks for common alcohol types (National Institute on Alcohol Abuse and Alcoholism, 2023). Daily psychological measures used the stem "Thinking about the day you had *yesterday*, how true were the below statements for you". These included a 6-item daily measure of daily need frustration with example items including "I felt pressured to do too many things", and "I felt that people who are important to me were cold and distant toward me". $\omega_{within} = 0.69$ [95% CI 0.67, 0.71], $\omega_{between} = 0.93$ [95% CI 0.92, 0.94]. We also included a need satisfaction measurement which took the same form, example items included "I felt close and connected with other people who are important to me", and "I felt a sense of choice and freedom in the things I undertook". $\omega_{within} = 0.78$ [95% CI 0.76, 0.79], $\omega_{between} = 0.97$ [95% CI 0.96, 0.97]. Additional variables were included that do not relate to this study and are not reported here. These variables were: Vitality and Depletion, Life Satisfaction, the General Health Questionnaire, and Emotion Regulation. For details, see the pre-registration.

**Data Exclusions.** Potentially eligible participants were given a qualification survey. Those who did not meet criteria were excluded prior to being given the baseline survey. Following data collection, as pre-registered, we removed participants who failed attention check questions from baseline (3 observations from 3 participants), and daily surveys (8 observations from 8 participants). No participant completed the survey unusually quickly

according to our exclusion criteria. The speed threshold for exclusion was a completion time more than three median absolute deviations below the median. We identified a small number of instances where participants appeared more than once in baseline (6 observations from 2 participants) and daily datasets (5 observations from 4 participants). When there were duplicate data, we retained the first submitted observation. However, in one case, a participant partially started a diary, but then re-completed it in full at a later date. In this instance, their subsequent complete diary was retained over their earlier incomplete diary.

**Analysis.** For the primary analysis, we fit a series of mixed-effects models where the number of daily drinks was predicted by need satisfaction from alcohol (measured at baseline, H4) and moderated by daily psychological need frustration (H5). For each outcome, we used the same sequence of models as used in Study 1, but using daily frustration instead of general frustration. We included random intercepts for participants to account for repeated measurements. Age and sex were included as covariates in all Study 2 mixed-effects models. Age was standardized ($z$-scored), and sex was coded as female = 1, non-female = 0, then mean-centered, so intercepts represent expected outcomes at mean age and the sample-average sex composition. We used "glmmTMB" version 1.1.14 to fit mixed-effects models (McGillycuddy et al., 2025). Model convergence was checked with "performance" version 0.16.0 (Lüdecke et al., 2021); all models converged. Effects were extracted with "ggeffects" version 2.3.2 (Lüdecke, 2018).

As our outcomes were drinks per day (count) and any drinking (binary), we analysed untransformed outcome variables using model families appropriate to each outcome type. For the main outcome (drinks per day), we compared competing model families. We fitted Gaussian, Poisson, negative binomial type 1 (nbinom1), and negative binomial type 2 models, and selected the preferred model using the smallest AIC. As a sensitivity check, we repeated analyses with the number of drinks consumed winsorized at the upper 1% of the distribution (pattern and interpretation unchanged, see supplementary materials, Table S5). For the secondary analysis, we tested whether drinking anything on a given day was

associated with need satisfaction from alcohol (H4), and whether this association was moderated by daily need frustration (H5). This model was a mixed-effects logistic regression with the same predictors and random effects as the mixed model, but with a binomial family. Missing data were handled with listwise deletion. The sample used in each model is listed in table notes. As a supplementary analysis, using Study 2 data we replicated the Study 1 cross-sectional analysis. Because general basic psychological need frustration was not assessed at baseline, we predicted AUDIT scores from the interaction between need satisfaction from alcohol and mean need frustration across the diary study.

**Power Analysis.** A Monte-Carlo power analysis (simr, 1000 simulations) suggested a sample of N = 400, where each participant has a baseline assessment and four diary entries (5 timepoints), would yield 91% power (95 % CI 0.89–0.93) to detect a weak interaction (b = 0.08) when predicting drinks consumed per day (adjusted ICC = 33%). See pre-registration for more details, including power analysis for the secondary outcome (Lavoie et al., 2023).

**Protocol deviations.** We aimed to meet our pre-registered sample size of N = 400 participants completing diaries. However, it was not feasible to run the collection sequentially so we recruited in two waves. We over-estimated attrition resulting in a larger sample collected than pre-registered: 581 complete diaries were collected (Figure 2). As we only began analysis after data-collection was complete this did not introduce bias, instead increasing the precision of our estimates. However, it was nonetheless an unintentional deviation from our pre-registered plan. We pre-registered that we would use the same items for need satisfaction from alcohol as Conigrave et al. (2021), however we used a refined set of nine items based on that original scale (the same items as Study 1). We intended to impute missing data, however there was very little missing data, so instead, for parsimony, we opted to use listwise deletion. We preregistered removal of multivariate outliers (Lavoie et al., 2023), but predictor variables were likert scales with limited range, and outcome variables were capped making true outlier detection and impact ambiguous, so this was never performed. Our model comparison technique was consistent with our pre-registered plan of

not using variable normalization transformations if they harmed interpretability; however, the specific families that allowed us to use non-transformed data, and the technique we used to compare them (AIC) were not pre-registered. Additional to the pre-registered plan we performed an exploratory decomposition of the between and within effects of daily need frustration. We also controlled for age and female status in regression models which did not change the pattern of results.

## Results

**Descriptive Statistics and Intercorrelations.** Study 2 comprised a total of 786 unique participants and 3358 observations. The mean age of participants was 39.82 years (SD = 12.65). The sample was approximately evenly split by sex, with 47.50% identifying as female, and 50.80% as male. A further 1.78% identified as non-binary or chose not to disclose their sex. Participants had diverse socio-economic statuses. Just under half (45.90%) reported annual earnings of less than $50,000, 34.40% earned between $50,000 and $100,000, and 19.70% earned over $100,000. Nearly two-thirds had completed college (65.10%) or attained a higher qualification, whereas just over one-third (34.90%) had not completed a college degree. Employment status indicated that more than two-thirds (68.20%) of participants were employed full-time, while 14.60% were employed part-time, and 17.20% were unemployed. Intercorrelations, means and standard deviations for all Study 2 constructs as measured at baseline are presented in Table 3. Consistent with Study 1, at baseline, need satisfaction from alcohol was correlated positively with AUDIT score (supports H1). Daily need frustration measured at baseline was positively correlated with AUDIT score, whereas daily need satisfaction was not correlated with AUDIT. AUDIT scores tended to go down with age and were unrelated to participants' reported gender. The mean AUDIT score was 8.09 (SD = 5.99), similar to that found in Study 1, and slightly higher than typical mean AUDIT scores for non-clinical samples (M = 5.67, SD = 4.48; Y. Chen et al., 2024). The interaction between need satisfaction from alcohol and general need

frustration (using mean daily frustration as a proxy) was replicated, $b = 0.66$ [95% CI 0.48, 0.84] (see Supplementary Materials Table S4, for the full model, consistent with H3).

**Predicting Daily Drinks.** We ran a series of hierarchical regression models to predict daily drinks consumed from the previous day. We fit and compared the AICs of a Gaussian family model (AIC = 14,819.73), Poisson (AIC = 11,753.30), negative binomial type 1 (AIC = 11,452.23), and negative binomial type 2 models (AIC = 11,469.71). The negative binomial type 1 model gave the best fit based on AIC, and so was preferred. Table 4 presents findings from a hierarchical mixed-effects regression using the nbinom1 family. In Model 1, we show people consumed an average of 1.22 [95% CI 1.13, 1.33] drinks the day before completing each survey. There was a main effect of need satisfaction from alcohol $\chi^2(1) = 23.39$, $p = < .001$ (supports H4). Each standard deviation increase in need satisfaction from alcohol was associated with a 21% increase in the number of standard drinks consumed yesterday (IRR = 1.21 [95% CI 1.12, 1.31]). In Model 3, adding daily need frustration to the model did not significantly improve model fit to the data $\chi^2(1) = 0.33$, $p = .563$. Model 4 revealed a borderline statistically significant interaction (p = .049) where the effect of need satisfaction from alcohol on the rate of daily drinking was slightly stronger for those with higher daily need frustration $\chi^2(1) = 3.91$, $p = .048$ (visualised in Figure 3). Repeating the analysis with outcome winsorization at the upper 1% of the distribution made the p-value non-significant (p = .082; see Supplementary Materials). We explored whether patterns of results changed after decomposing daily need frustration into within- and between-person components. This supplementary analysis revealed a borderline, statistically significant interaction effect for between-person (mean) daily frustration on the rate of drinking (IRR = 1.07 [95% CI 1.00, 1.16]), but not for within-person daily frustration (see Supplementary Materials, Table S6). This pattern of results which straddles the borderline of our signficance criteria suggests weak and uncertain support for H5.

**Predicting Odds of Having Drinking Occasions.** As a secondary analysis, we tested whether the interaction between daily need frustration and need satisfaction from

alcohol also predicted drinking anything. Table 5 presents these findings. In Model 1, we show that people were more likely than not to drink on a given day, OR = 1.74 [95% CI 1.51, 2.02]. Adding baseline need satisfaction from alcohol significantly improved model fit $\chi^2(1) = 8.08$, $p = .004$. Participants who were +1 SD above average in need satisfaction from alcohol were more likely to drink OR = 1.23 [95% CI 1.07, 1.43] on a given day than others (supports H4). We did not find a main effect of daily need frustration (Model 3). We did not find a statistically significant interaction between daily need frustration and satisfaction from alcohol in Model 4 $\chi^2(1) = 2.06$, $p = .151$ (does not support H5). Finally, we explored how results changed when decomposing within- and between-person effects in predicting the odds of drinking anything. This analysis revealed a statistically significant interaction effect for between-person mean daily frustration on the likelihood of drinking, but not for within-person daily frustration (OR = 1.17 [95% CI 1.01, 1.35]; see Supplementary Materials, Table S7).

## General Discussion

We sought to perform a preliminary test of SDT's need density hypothesis in relation to alcohol consumption. We expected to find that people who experience more need satisfaction from alcohol would report riskier drinking, and that effect would be greater for people who also experience general basic psychological need frustration. Across two studies, we found consistent support for the first of these predictions. Individuals who found alcohol need-satisfying reported more hazardous/harmful consumption (H1), marking the first such evidence in a general population sample (Conigrave et al., 2021). Cross-sectionally, this association was stronger among those with greater general need frustration (H3). Daily diary data showed that need satisfaction from alcohol predicted both the likelihood of drinking each day and overall consumption (H4). These relationships were inconsistently amplified by daily need frustration (H5), with exploratory analyses suggesting between-person mean levels of need frustration may drive any moderating effect of need frustration, rather than

within-person fluctuations. Together, these findings provide mixed support for the application of the need density hypothesis to alcohol consumption.

The need density hypothesis proposes that individuals may engage in maladaptive yet need-satisfying behaviors, such as alcohol consumption, to compensate for frustrated basic psychological needs (Rigby & Ryan, 2011). While the interaction between daily need frustration and need satisfaction from alcohol use was inconsistent, the cross-sectional interaction between general need frustration and need satisfaction from alcohol was strong and potentially clinically meaningful. This pattern of results suggests that individuals may turn to alcohol as a way to meet basic psychological needs when they have chronically frustrated basic psychological needs, rather than due to daily fluctuations in need frustration. If future research confirms hazardous/harmful drinking is driven in-part by attempts to meet chronically frustrated needs, this would have important practical implications: Helping individuals find safer, more adaptive ways to satisfy their basic psychological needs, and manage need-frustration, would likely reduce harmful alcohol use.

### Drinking Habituation Via Need Compensation

Our results suggest drinking patterns are linked to basic psychological needs. The interaction effect identified in Study 1 was strong; when people found alcohol highly need-satisfying, mean levels of AUDIT were highly dependent on general need frustration, with predictions crossing all three risk bands of the 10-item AUDIT. Those who did not find alcohol need-satisfying had mean AUDIT scores in the low-risk range irrespective of frustration. This cross-sectional finding was replicated using data from Study 2.

When we re-examined the links between basic psychological needs and alcohol consumption longitudinally, the main effect of need satisfaction from alcohol on both the likelihood and quantity of consumption persisted. People who reported higher need satisfaction from alcohol (+1 SD) consumed about 21% more standard drinks per day. The

moderating effect of daily frustration on the relationship between need satisfaction from alcohol and drinking was less clear. A borderline interaction was found, which did not survive sensitivity tests. Decomposing the model into within- and between components showed that any moderating effect of need frustration was driven by between-person variation in mean levels of frustration, rather than day-to-day fluctuations. No moderation effect emerged for the likelihood of drinking on a given day.

Together, these findings are consistent with alcohol use being largely habitual, rather than responding meaningfully to day-to-day fluctuations in daily need frustration. This is similar to how daily subjective stress is inconsistently associated with subsequent alcohol consumption outside of heavier-drinking or treatment-seeking populations (Wolkowicz et al., 2022). Even if needs are unusually frustrated on a given day, people will generally have multiple domains where they can correct for frustrated needs, with the more domains resulting in need satisfaction, the more stable a person's well-being (Milyavskaya et al., 2009). For a potentially maladaptive behavior (such as drinking alcohol) to be chosen for need compensation over alternatives, it would likely be perceived as more available, and/or more satisfying than other options (Rigby & Ryan, 2011). This may not be the case if someone normally feels need-satisfied in other areas of their life.

Accordingly, more chronic need frustration, rather than day-to-day fluctuation in need frustrations, may be more important in the establishment of alcohol as a maladaptive compensatory behavior, which over time can form into a habit, compulsion, and can then crystallize into more harmful drinking and possibly dependence (Everitt & Robbins, 2005). Intervening on general need frustration is likely important before a range of maladaptive need-compensatory behaviors become habituated (Giannone et al., 2024; Hawkins et al., 1992; Rigby & Ryan, 2011; Ryan & Deci, 2017; Sharifi Fard et al., 2023).

**Implications for Practice**

Alcohol use may serve as a form of compensation for chronic need frustration for some individuals. This presents challenges for treatment, which often focuses on eliminating problematic behaviors such as alcohol consumption rather than adopting well-being oriented approaches that emphasize meeting needs (Shen et al., 2013). Simply removing alcohol, without ensuring availability of other healthier means of needs support and satisfaction, may be ineffective, or even costly for those who have relied on alcohol to meet their needs, and could contribute to feelings of being controlled, complicating treatment adherence (Ryan et al., 1995). That said, we also acknowledge that for some people risky alcohol consumption may be a maladaptive coping strategy that requires strong intervention. This can include people who for medical reasons need to immediately cease alcohol consumption (American Society of Addiction Medicine, 2023). Even in such cases, following stabilization, a clearer understanding of how basic psychological needs relate to drinking could help improve care.

Our findings suggest that, whatever the treatment goal, understanding the functions alcohol serves, addressing *chronic* need frustration, and helping people satisfy their needs in safe ways could support better outcomes. Indeed, reduced consumption in some cases may occur as a by-product of efforts to better satisfy, or manage frustration of, basic psychological needs without direct intervention on drinking. This would require working with patients to identify how alcohol meets their needs, and what other activities or relationships could take on that role. Then, an action plan that considers barriers and enablers, could be developed to support those alternatives. The utility of a needs-based approach is supported by evidence that people with alcohol dependence, but who also have satisfied basic psychological needs, experience lower cravings and greater confidence in maintaining abstinence (Tabiś & Poprawa, 2023).

In some settings, such as disadvantaged communities, socio-economic deprivation may make addressing need frustration, and supporting the satisfaction of basic psychological

needs especially difficult. In such cases, building 'needs infrastructure', such as sporting grounds, community centers, and other socio-economic opportunities which meet basic psychological needs, may prove helpful in indirectly reducing consumption, especially when implemented alongside other health promotion programs and interventions (Munro et al., 2022).

### Implications for Self-Determination Theory

The findings in this paper are broadly consistent with SDT's need density hypothesis (Rigby & Ryan, 2017; Ryan & Deci, 2017; Vansteenkiste & Ryan, 2013). While our research is compatible with SDT research showing alcohol is related to need frustration, our results also highlight that experiences of need satisfaction from alcohol potentiate alcohol use as a way to compensate for frustrated needs. In the context of general need frustration, positive in-the-moment experiences of alcohol consumption may nudge people towards higher-risk drinking over time. These findings align with other SDT research into motivation for engaging in addictive entertainment media such as video games, internet, and social media use (Adachi & Rigby, 2023; Allen & Anderson, 2018; Rigby & Ryan, 2011; Sharifi Fard et al., 2023; Shen et al., 2013).

It is important to again stress that while people can feel need-satisfied while drinking, that does not mean that alcohol use is a healthy or adaptive way to meet basic psychological needs. Alcohol use is clearly associated with a range of negative health and psychological outcomes (World Health Organization, 2024), and heavy use can crowd out opportunities for better ways to feel need satisfaction (Ryan & Deci, 2017). However, it is crucial to understand the potential ways people are drawn to alcohol use in order to find better ways to reduce hazardous and harmful drinking (Kuntsche et al., 2005).

**Future directions**

Our research may be relevant to work on alcohol expectancies (Jones et al., 2001). This research shows that stronger positive expectancies about alcohol's effects are associated with heavier drinking, and modifying these expectancies can reduce consumption (Darkes & Goldman, 1993). Based on our findings, we would expect that an important class of expectancies is that alcohol will satisfy basic psychological needs. Future work should examine whether alcohol expectancies can explain the association between need satisfaction from alcohol and hazardous/harmful drinking. Interventions that challenge need-related expectancies, for example by helping clients notice when alcohol does not reliably meet these needs, particularly over longer spans of time, could be a useful target.

There is clear conceptual overlap between the drinking motives literature and basic psychological needs theory. Enhancement motives may be linked to the need for autonomy, confidence to competence, and social/conformity motives to relatedness. Work is needed to integrate these theories, and in particular to understand whether attraction to certain drinking motives is driven by expected need satisfaction, or the avoidance of need frustration. It is currently unclear whether need satisfaction from alcohol provides incremental predictive power over drinking motives, or whether its role might be more theoretical, in better understanding the mechanisms by which explicit drinking motives influence drinking behavior.

Need satisfaction from alcohol may operate differently at different stages of drinking. It may be especially influential when habits are forming, such as among college students. Later, associations with drinking could weaken when use has become habitual and heavy, such as among individuals receiving treatment for alcohol dependence. For many, perceptions of alcohol as need-satisfying or frustrating may change over time. Early positive, need-satisfying experiences may help establish enduring drinking patterns, yet alcohol may later become need-frustrating as negative consequences accumulate. To study these

dynamics, the effects of need satisfaction from alcohol on outcomes could be compared among cohorts with different drinking patterns (e.g., college students, general community, and clinical samples), or across longer spans of time.

### Limitations

Our findings remain correlational. Study 2 captured longitudinal effects (i.e., baseline need satisfaction from alcohol predicting daily drinking), but causation, while suggested by temporal ordering, cannot be established without experimental designs. We treated need satisfaction from alcohol as a stable trait, measuring it only at baseline. While we expect general need satisfaction from alcohol to be relatively stable, it may also vary between drinking occasions and those variations could be important. Murphy et al. (2023) have questioned whether the BPNSFS measures two substantively distinct constructs (satisfaction and frustration), or a single construct that often clusters into two due to item-key method artifacts. While experimental and longitudinal work support the substantive distinction between satisfaction and frustration, and align with BPNSF scale predictions (Ryan & Deci, 2017), methods that can conclusively separate substantive variance from method artifacts, or the development of new scales, could improve need satisfaction and frustration measurement, and thereby strengthen predictions (see Marsh et al., 2025).

We made decisions about the collection of data that proved limiting. Data were collected reflecting on the previous day's behavior and experiences of frustration. The use of ecological momentary assessment in future studies would provide more accurate data, as more precise experiences of frustration at the moment of initiating drinking could be measured. All measures were self-reported, introducing potential bias. Objective consumption data and multi-method approaches would strengthen validity of future research. Further, our samples, while diverse, were drawn from U.S. convenience samples and may not generalize to other cultural or clinical populations. Our participant pool in Study 1 was predominantly white. We did not measure ethnicity in Study 2. We included participants

who drank infrequently (1 standard drink per week or more) in Study 2. A longer diary period would have been better suited to such drinking patterns. Longer diary studies, or those targeting people who drink more frequently, may yield more robust findings.

## Conclusion

We found strong correlational evidence supporting the need density hypothesis where general need frustration amplified the association between need satisfaction from alcohol and hazardous/harmful drinking as measured by AUDIT. Need satisfaction from alcohol also predicted daily drinking; however, the moderation effect from need frustration was weak and uncertain at the daily level. These findings suggest that chronic, rather than transient need frustration is related to greater daily consumption and broader harmful alcohol use among those who find alcohol need-satisfying. Helping people find more adaptive need-compensatory behaviors may support reduction of harmful alcohol consumption.

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Table 1

*Intercorrelations for All Constructs in Study 1.*

| | 1 | 2 | 3 | 4 | 5 | M | SD |
|---|---|---|---|---|---|---|---|
| 1. AUDIT | - | | | | | 7.84 | 8.15 |
| 2. NS from alcohol | .58*** | - | | | | 2.78 | 1.19 |
| 3. BPN-S | .01 | .06 | - | | | 3.82 | 0.76 |
| 4. BPN-F | .53*** | .51*** | -.32*** | - | | 2.39 | 1.00 |
| 5. Age | -.40*** | -.49*** | .14*** | -.44*** | - | 48.88 | 16.88 |
| 6. Female | -.26*** | -.14*** | -.16*** | -.04 | -.08* | 0.49 | 0.50 |

*Note.* N = 742, NS from alcohol = Need Satisfaction from Alcohol, AUDIT = Alcohol Use Disorders Identification Test, BPN-S = Basic Psychological Needs Satisfaction, BPN-F = Basic Psychological Needs Frustration; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2

*Hierarchical Regression Model Using Satisfaction from Alcohol and General Need Frustration to Predict AUDIT Scores in Study 1 (Age and Sex Adjusted)*

| Term | b [95% CI] | SE | t | p | R2 | $\triangle R^2$ |
|---|---|---|---|---|---|---|
| Model 1 | | | | | 24.13% | |
| Intercept | 7.84 [7.33, 8.35] | 0.26 | 30.09 | $< .001$ | | |
| Model 2 | | | | | 39.07% | 14.94% |
| Intercept | 8.05 [7.59, 8.51] | 0.23 | 34.40 | $< .001$ | | |
| NS from alcohol ($z$) | 3.67 [3.14, 4.21] | 0.27 | 13.50 | $< .001$ | | |
| Model 3 | | | | | 45.12% | 6.05% |
| Intercept | 8.19 [7.76, 8.63] | 0.22 | 36.81 | $< .001$ | | |
| NS from alcohol ($z$) | 2.74 [2.19, 3.29] | 0.28 | 9.86 | $< .001$ | | |
| Need frustration ($z$) | 2.45 [1.92, 2.98] | 0.27 | 9.08 | $< .001$ | | |
| Model 4 | | | | | 48.14% | 3.02% |
| Intercept | 7.42 [6.94, 7.91] | 0.25 | 30.26 | $< .001$ | | |
| NS from alcohol ($z$) | 2.79 [2.26, 3.32] | 0.27 | 10.33 | $< .001$ | | |
| Need frustration ($z$) | 2.15 [1.63, 2.67] | 0.27 | 8.05 | $< .001$ | | |
| NS from alcohol ($z$) $*$ Need frustration ($z$) | 1.45 [1.02, 1.88] | 0.22 | 6.63 | $< .001$ | | |

*Note.* Scaled variables indicated with '($z$)'. All models were adjusted for age and sex (these coefficients are omitted for readability). NS from alcohol = Need Satisfaction from Alcohol. N = 742; 0 observations excluded due to missing data.

Table 3

*Baseline Intercorrelations for All Constructs in Study 2.*

| | 1 | 2 | 3 | 4 | 5 | M | SD |
|---|---|---|---|---|---|---|---|
| 1. NS from alcohol | - | | | | | 4.52 | 1.25 |
| 2. AUDIT | .36*** | - | | | | 8.09 | 5.99 |
| 3. BPN-S | -.07 | -.26*** | - | | | 4.15 | 1.13 |
| 4. BPN-F | .18*** | .33*** | -.61*** | - | | 2.28 | 1.06 |
| 5. Age | -.23*** | -.09** | .15*** | -.12** | - | 39.82 | 12.65 |
| 6. Female | -.02 | -.14*** | -.01 | -.02 | .01 | 0.47 | 0.50 |

*Note.* N = 783 – 786, NS from alcohol = Need Satisfaction from Alcohol, AUDIT = Alcohol Use Disorders Identification Test, BPN-S = Daily Basic Psychological Needs Satisfaction, BPN-F = Daily Basic Psychological Needs Frustration; BPN-S and BPN-F reference 'yesterday' rather than life in general

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 4

*Hierarchical Regression Model Predicting Daily Drinks (Age and Sex Adjusted).*

| Term | IRR [95% CI] | lnIRR | SE | z | p | Likelihood Ratio Test |
|---|---|---|---|---|---|---|
| Model 1 | | | | | | |
| Intercept | 1.22 [1.13, 1.33] | 0.20 | 0.04 | 4.83 | $< .001$ | |
| Model 2 | | | | | | $\chi^2(1) = 23.39$, $p = < .001$ |
| Intercept | 1.22 [1.13, 1.33] | 0.20 | 0.04 | 4.93 | $< .001$ | |
| NS from alcohol ($z$) | 1.21 [1.12, 1.31] | 0.19 | 0.04 | 4.85 | $< .001$ | |
| Model 3 | | | | | | $\chi^2(1) = 0.33$, $p = .563$ |
| Intercept | 1.23 [1.13, 1.33] | 0.20 | 0.04 | 4.95 | $< .001$ | |
| NS from alcohol ($z$) | 1.21 [1.12, 1.31] | 0.19 | 0.04 | 4.80 | $< .001$ | |
| Daily frustration ($z$) | 1.02 [0.96, 1.07] | 0.02 | 0.03 | 0.58 | .563 | |
| Model 4 | | | | | | $\chi^2(1) = 3.91$, $p = .048$ |
| Intercept | 1.22 [1.12, 1.32] | 0.20 | 0.04 | 4.76 | $< .001$ | |
| NS from alcohol ($z$) | 1.22 [1.13, 1.32] | 0.20 | 0.04 | 4.95 | $< .001$ | |
| Daily frustration ($z$) | 1.00 [0.95, 1.06] | 0.00 | 0.03 | 0.02 | .983 | |
| NS from alcohol ($z$) $*$ Daily frustration ($z$) | 1.06 [1.00, 1.11] | 0.05 | 0.03 | 1.97 | .049 | |

*Note.* ($z$) = scaled variable. NS from alcohol = Need Satisfaction from Alcohol. Models included random intercepts for participants and were adjusted for age and sex; covariate coefficients are omitted for readability. IRR = incident rate ratio; lnIRR = Natural logarithm of the incident rate ratio; LRT = likelihood ratio test statistic. The IRR is the multiplicative change in the expected number of drinks consumed for each one unit increase in the predictor variable. N (complete cases) = 3355; 3 observations excluded due to missing data.

Table 5

*Hierarchical Logistic Mixed-effects Models Predicting Drinking Anything (Age and Sex Adjusted).*

| Term | OR [95% CI] | lnOR | SE | z | p | Likelihood Ratio Test |
|---|---|---|---|---|---|---|
| Model 1 | | | | | | |
| Intercept | 1.74 [1.51, 2.02] | 0.56 | 0.07 | 7.49 | $< .001$ | |
| Model 2 | | | | | | $\chi^2(1) = 8.08$, $p = .004$ |
| Intercept | 1.74 [1.51, 2.01] | 0.56 | 0.07 | 7.53 | $< .001$ | |
| NS from alcohol ($z$) | 1.23 [1.07, 1.43] | 0.21 | 0.07 | 2.84 | .005 | |
| Model 3 | | | | | | $\chi^2(1) = 0.46$, $p = .498$ |
| Intercept | 1.74 [1.51, 2.01] | 0.56 | 0.07 | 7.54 | $< .001$ | |
| NS from alcohol ($z$) | 1.23 [1.06, 1.42] | 0.21 | 0.07 | 2.78 | .005 | |
| Daily frustration ($z$) | 1.04 [0.92, 1.18] | 0.04 | 0.06 | 0.68 | .497 | |
| Model 4 | | | | | | $\chi^2(1) = 2.06$, $p = .151$ |
| Intercept | 1.72 [1.49, 1.99] | 0.54 | 0.07 | 7.37 | $< .001$ | |
| NS from alcohol ($z$) | 1.24 [1.07, 1.44] | 0.22 | 0.07 | 2.91 | .004 | |
| Daily frustration ($z$) | 1.03 [0.92, 1.17] | 0.03 | 0.06 | 0.54 | .589 | |
| NS from alcohol ($z$) $*$ Daily frustration ($z$) | 1.09 [0.97, 1.23] | 0.09 | 0.06 | 1.43 | .152 | |

*Note.* ($z$) = scaled variable. NS from alcohol = Need Satisfaction from Alcohol. Models included random intercepts for participants and were adjusted for age and sex; covariate coefficients are omitted for readability. N (complete cases) = 3355; 3 observations excluded due to missing data.

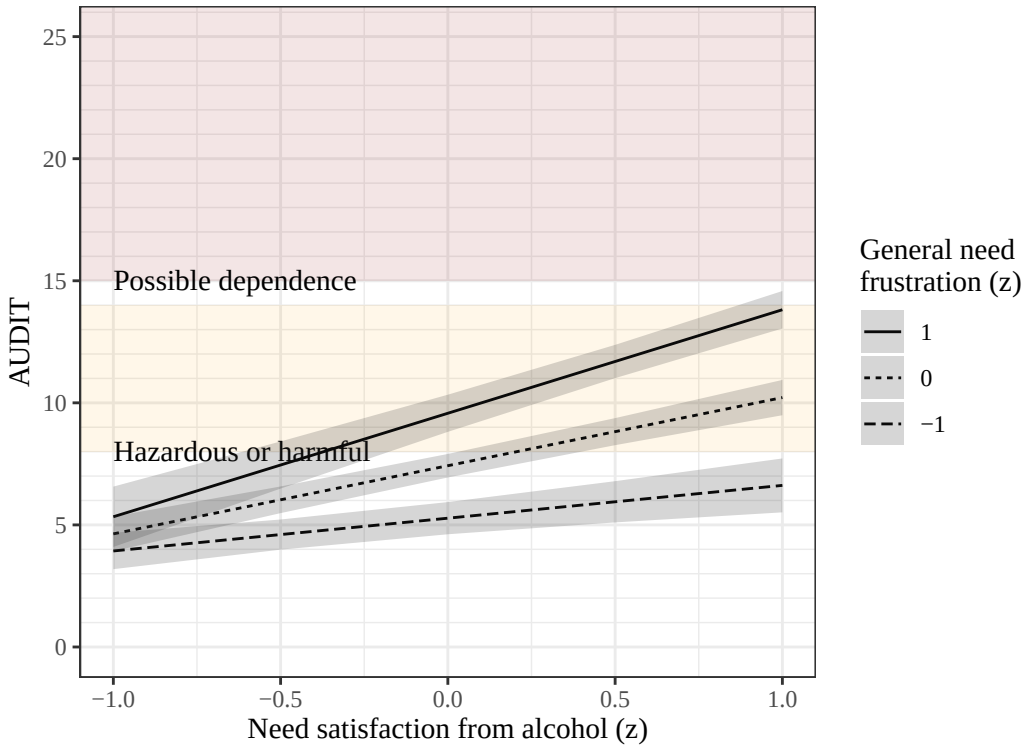


*Figure 1*. Predicted AUDIT scores by need satisfaction from alcohol and basic psychological needs frustration (Model 4; age and sex adjusted).

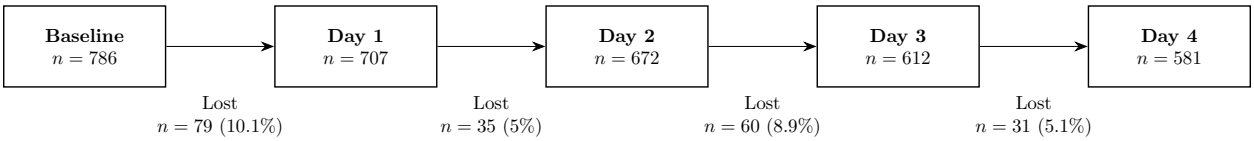


*Figure 2*. Study 2 recruitment flow diagram showing attrition between diary entries

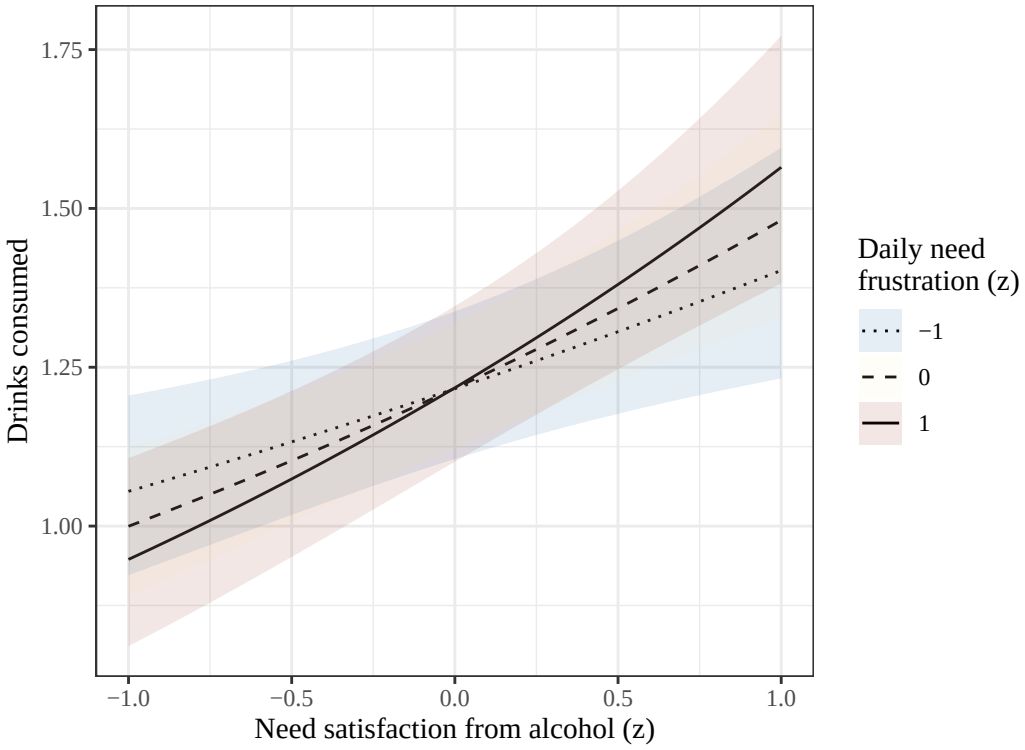


*Figure 3*. Predicted drinks by daily frustration and need satisfaction from alcohol (Model 4; age and sex adjusted). Predictors are scaled (z).