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Combinations of Drinking Occasion Characteristics Associated with Units of Alcohol Consumed among British Adults: An Event-Level Decision Tree Modeling Study

Abigail K. Stevely , John Holmes, and Petra S. Meier

Background: Alcohol consumption is influenced by the characteristics of drinking occasions, for example, location, timing, or the composition of the drinking group. However, the relative importance of occasion characteristics is not yet well understood. This study aims to identify which characteristics, and combinations of characteristics, are associated with units consumed within drinking occasions. It also tests whether accounting for occasion characteristics improves the prediction of consumption compared to using demographic information only.

Methods: The data come from a cross-sectional, nationally representative, online market research survey. Our sample includes 18,409 British drinkers aged 18 + who recorded the characteristics of 46,072 drinking occasions using 7-day retrospective drinking diaries in 2018. We used decision tree modeling and nested linear regression to predict units consumed in occasions using information on drinking location/venue, occasion timing, company, occasion type (e.g., a quiet night in), occasion motivation, drink type and packaging, food eaten and entertainment/ other activities during the occasion. We estimated models separately for 6 age-sex groups and controlled for usual drinking frequency, and social grade in nested linear regression models. Open Science Framework preregistration: <https://osf.io/42epd>.

Results: Our 6 final models accounted for between 55% and 71% of the variance in drinking occasion alcohol consumption. Beyond demographic characteristics (1 to 9%) and occasion duration (24 to 60%), further occasion characteristics and combinations of characteristics accounted for 31 to 70% of the total explained variance. The characteristics most strongly associated with heavy alcohol consumption were long occasion duration, drinking spirits as doubles, and drinking wine. Spirits were also consumed in light occasions, but as singles. This suggests that the serving size is an important differentiator of light and heavy occasions.

Conclusions: Combinations of occasion duration and drink type are strongly predictive of alcohol consumption in adults' drinking occasions. Accounting for characteristics of drinking occasions, both individually and in combination, substantially improves the prediction of alcohol consumption.

Key Words: Alcohol Drinking, Epidemiology, Adult, Contexts, Drinking Occasions.

THERE IS A growing literature using event-level methods to study the relationships between characteristics of drinking occasions and drinking behavior (Stevely et al., 2019). The existing literature has identified occasion characteristics associated with increased alcohol consumption such

as predrinking, drinking with multiple friends, and drinking at the weekend (Kuntsche and Labhart, 2013; Labhart et al., 2013, 2014; Thrul and Kuntsche, 2015; Thrul et al., 2017). Research in this area can help to shape our thinking about which occasions are likely to involve problematic drinking, how policies may affect these occasions, and how to develop and refine occasion-specific interventions for occasions associated with heavy consumption (Clapp et al., 2008; Kuntsche and Labhart, 2013; Stanesby et al., 2019; Stevely et al., 2019, 2020a; Thrul and Kuntsche, 2015). However, it is not yet clear which characteristics are most strongly associated with alcohol consumption and whether occasion characteristics combine to produce important effects on outcomes, or whether there are interaction effects between characteristics (Stevely et al., 2019).

In our study, we were particularly interested in exploring the importance of joint effects of different drinking occasion characteristics on units of alcohol consumed. We conceptualized drinking occasions as social practices, since this theoretical perspective is well suited to studying combinations of

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characteristics (Blue et al., 2016; Meier et al., 2017; Shove et al., 2012). Reckwitz defines practices as:

a routinised type of behaviour which consists of several elements, interconnected to one another: forms of bodily activities, forms of mental activities, ‘things’ and their use, a background knowledge in the form of understanding, know-how, states of emotion and motivational knowledge. (Reckwitz, 2002, p. 249)

For example, in the UK “going out with friends” tends to make us think of occasions that involve characteristics of socializing and drinking with a group of friends in licensed premises, typically on a weekend evening. Crucially for the current paper, using this approach emphasizes the relationships between different aspects of the drinking context that come together to form a practice (Meier et al., 2017). So far, research in this area has tended to rely on linear regression models which assume independence of effects of characteristics on outcomes (Clapp et al., 2008; Stevely et al., 2019; Wells et al., 2008). Instead, we need conceptual and analytical approaches that properly account for the combined effects of occasion characteristics, which may improve our understanding of their cumulative effects on alcohol consumption.

Our study aims to identify the combinations of characteristics that are associated with units consumed within adults’ drinking occasions in Great Britain and which characteristics are the strongest predictors of alcohol consumption. It also aims to test whether accounting for occasion characteristics (individually and in combinations) improves the prediction of consumption relative to models including only demographic characteristics.

MATERIALS AND METHODS

Data

We used data from the 2018 Alcovision survey, collected by the market research company Kantar. Alcovision is a continuous online survey that includes a detailed retrospective 7-day drinking diary and measures of socio-demographic characteristics and usual drinking frequency. The drinking diary collects information about drinking occasions, defined by Kantar as periods of drinking in only the on-trade (in licensed premises such as pubs) or only the off-trade (such as at home). Our analysis instead redefined drinking occasions as periods of drinking with no 2-hour gaps between drinks. This allowed occasions in the dataset to be combined to include both on- and off-trade locations (e.g., preloading before a night out).

The sample was taken from an online market research panel using monthly quotas based on age, sex, social grade, and geographic region. Survey invitations were sent continuously throughout the year to ensure that responses covered every day of the year. The original sample was 29,599 adults (18+) resident in Great Britain. Our analytic sample included 18,409 drinkers, excluding non-drinkers (respondents who report usually drinking “Less often than once in 12 months” or “Never”). Weighting was applied based on age, sex, social grade, and geographic region using Great Britain census data. Our analysis included 46,072 drinking occasions reported by the sample. Informed consent was given by all participants in the survey.

Measures

Outcome Measure. Our primary outcome measure was alcohol consumption in UK units within each drinking occasion (1 unit = 8 grams of alcohol). Units were calculated based on the number of servings reported by participants, serving size, and the alcohol by volume (ABV). Participants reported brands for most servings, and we used this information to identify actual ABVs via web searches. Where brand information was not available, we used standard ABVs for some beverage types.

Occasion Characteristics. A wide range of occasion characteristics were used in our analysis. This reflects our conceptualization of drinking occasions as social practices made up of materials (e.g., a glass of wine), meanings (e.g., drinking to chill out), and timings (e.g., the duration of the occasion) (Ally et al., 2016; Meier et al., 2017; Shove et al., 2012; Southerton, 2006; Stevely et al., 2019).

Occasion characteristics used in our analyses are day of the week, start time of the occasion (11 categories), duration (measured in 9 bands and we use mid-points as point estimates), month of the year, trade type (on-trade, off-trade, preloading, postloading, mixed, unclear), company type (6 categories; e.g., with friends, with family members), group structure (7 categories; e.g., male pair, female group, with children), entertainment (42 categories; e.g., watching television, listening to music), food consumption (11 categories; e.g., having a formal meal), drink type (10 categories; e.g., spirits or wine), drink packaging (20 categories; e.g., a 440ml can), venue (29 categories; e.g., a modern bar), motivation for drinking (12 categories; e.g., to wind down or chill out), type of occasion (31 categories; e.g., a sociable night in), and reason for the choice of venue (30 categories; e.g., “it’s my local”). Preloading occasions involved drinking in the off-trade and then the on-trade and postloading occasions started in the on-trade and moved to the off-trade. We defined mixed occasions as switching between the on- and off-trade more than once and labeled occasions as “unclear” when the order of on- and off-trade drinking was not reported.

The full set of occasion characteristics and their responses categories are shown in Table S1. The table also indicates that many of these characteristics are not mutually exclusive and/or are allowed to change across the course of an occasion. We have treated categories within variables as separate binary variables where necessary in the analyses to account for this. For example, if a participant reported drinking with friends at the start of an occasion, but later drank with family, both friends and family were classed as present using separate variables.

Controls and Stratifying Variables. We used measures of sex, age in years, usual drinking frequency, and social grade. Usual drinking frequency was measured by the question “Over the year as a whole, about how often do you drink any alcoholic drink of any kind?” with 10 response options (e.g., “3 to 5 times a week”). Social grade was recorded using National Readership Survey (NRS) categories which is an occupation-based measure ranging from workers in higher managerial positions to semi- or unskilled workers and those who are unemployed.

Statistical Analysis

Preregistered Analyses. This study was preregistered using Open Science Framework (<https://osf.io/42epd>) (Stevely et al., 2020b). The frequency of drinking in different contexts varies by age and sex, and there may also be differences in the relationships between occasion characteristics and consumption (Ally et al., 2016). All analyses were therefore stratified across 6 age-sex groups (18 to 35, 36 to 64, 65+).

The first stage of our analysis used decision tree modeling (recursive partitioning in JMP Pro 14.3) to predict units of alcohol per

drinking occasion based on occasion characteristics (details of these are in Table S1). Decision tree models start with all drinking occasions and then choose the best characteristic by which to split the data. The best split will create 2 groups of roughly equal size with the maximum difference in mean consumption (Hawkins et al., 2011; Kass, 1980; SAS Institute Inc, 1989-2019). For example, occasions could be split into under vs over 2 hours in duration. The modeling process is recursive as the created groups are then successively split on the next best characteristic. These models therefore inherently consider complex combinations of occasion characteristics. The final groups created by a decision tree model are referred to as leaves and are defined by the combination of all of the splits in predictor variables.

We used k-fold cross validation (5-fold) to prevent over-fitting. We also restricted the model so that the leaves would include a minimum of 1% of the sample of drinking occasions to avoid generating very small groups.

The second stage of our analysis estimated nested linear regression models (i.e., a series of models adding predictors to the previous model) to predict units consumed per occasion. We used clustered standard errors in Stata 15 to account for the clustering of drinking occasions within participants. The simplest models included age (within the age-sex strata), usual drinking frequency, and social grade. We then sequentially added: occasion duration, all of the occasion characteristics selected by decision tree models for each age-sex group, and the leaves generated by decision tree modeling. Occasion duration was added in a separate step as it showed a very strong association with consumption in decision tree models. For continuous predictors—age and duration—we included polynomial terms (to model nonlinear relationships) where these were significant at $\alpha = 0.1$.

The number of units per drinking occasion (our outcome variable) had a positive skew. We therefore log-transformed this variable for regression analyses. Occasions in the top 1% of the distribution of units per occasion were excluded due to concerns about extreme and possibly unreliable values. We used weighted data for all analyses.

Unplanned Analyses. We noted during decision tree modeling that the duration of the drinking occasion accounted for a large

proportion of the variance in units of alcohol consumed. Prior studies have also found that occasion characteristics can be associated with longer occasion duration (and therefore increased consumption) (Labhart et al., 2014). We therefore repeated the decision tree analysis with duration as the splitting criteria, rather than alcohol consumption, to identify characteristics that predict longer drinking occasions. We interpreted the findings from both sets of decision tree models to identify occasion characteristics with both direct effects on alcohol consumption in units and effects mediated by duration.

Ethics Approval

This study was approved by the University of Sheffield's ethics committee and conforms to the principles embodied in the Declaration of Helsinki. Use of this data is allowed under the terms of the contract and nondisclosure agreement between Kantar and the University of Sheffield, which requires research outputs to be submitted to the data provider ahead of publication. The data providers' right to request changes is limited to matters of accuracy regarding the data.

RESULTS

Decision Tree Modeling of Alcohol Consumption in Units

To identify the strongest predictors of units consumed, we consider the proportion of explained variance that is attributable to each predictor in decision tree models. Figure 1 shows the variables selected by the decision tree modeling of alcohol consumption in drinking occasions and their predictive contributions (results also reported in Table S2).

The duration of drinking occasions accounts for the highest proportion of explained variance in units consumed across all age-sex groups (ranging from 37.3% to 72.2%), with longer drinking occasions predictive of heavier consumption. Other important predictors are drinking spirits as

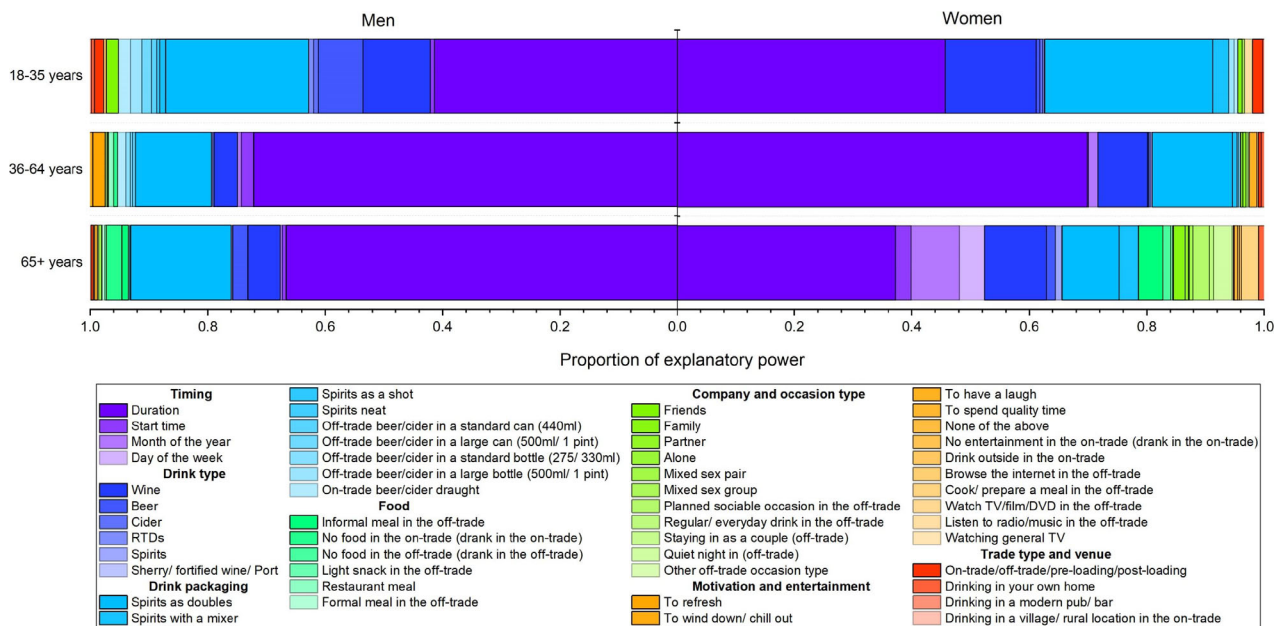


Fig. 1. The proportion of explained variance attributable to each characteristic in models of units of alcohol consumed per occasion for 6 age-sex groups.

doubles (particularly for 18 to 35 year olds—24.4% of explained variance for 18 to 25 year old men and 28.6% for women) and drinking wine (4.1 to 15.4%) (Table S2). There are other patterns across age-sex groups—for example, the type of beer/ cider packaging is more important in models of units per occasion for 18 to 35 year old men. Drinking large bottles (500ml/1 pint) of beer or cider in the off-trade and draught beer or cider in the on-trade is associated with increased consumption in this group.

Combinations of Occasion Characteristics Associated With Heavy Alcohol Consumption

Decision tree modeling produces a set of terminal nodes, or leaves, that are a combination of the splits throughout the tree. In our analysis, these represent combinations of characteristics of drinking occasions. Figure 2 shows the heaviest and lightest drinking leaves for each age-sex group (i.e., the combinations of occasion characteristics associated with the highest and lowest number of units consumed), following the branches of the decision tree models and showing the mean

units consumed at each node. We present only the lightest and heaviest occasions as the full decision trees produce many leaves and cannot be easily summarized. This section describes an example leaf in detail to illustrate their structure before presenting the overarching findings.

The lightest drinking leaf for men aged 36 to 64 has a mean consumption of 1.2 units. The most important predictor is that these occasions last less than an hour and a half. Within those that were shorter than 1.5 hours, the next most important determinant of consumption is not drinking spirits as doubles, followed by not drinking wine, drinking beer or cider in standard sized bottles (275/ 330ml) in the off-trade, the respondent considering the occasion type to be a regular/ everyday drink, and starting the occasion before 2pm.

Comparing across the age-sex groups reveals many commonalities, particularly within heavy drinking occasions—which are longer in duration and typically involve drinking spirits as doubles. However, among young adults (aged 18 to 25 years) the heaviest drinking occasions also involve drinking wine. Light drinking occasions are generally shorter, spirits are drunk as singles, and no wine is consumed.

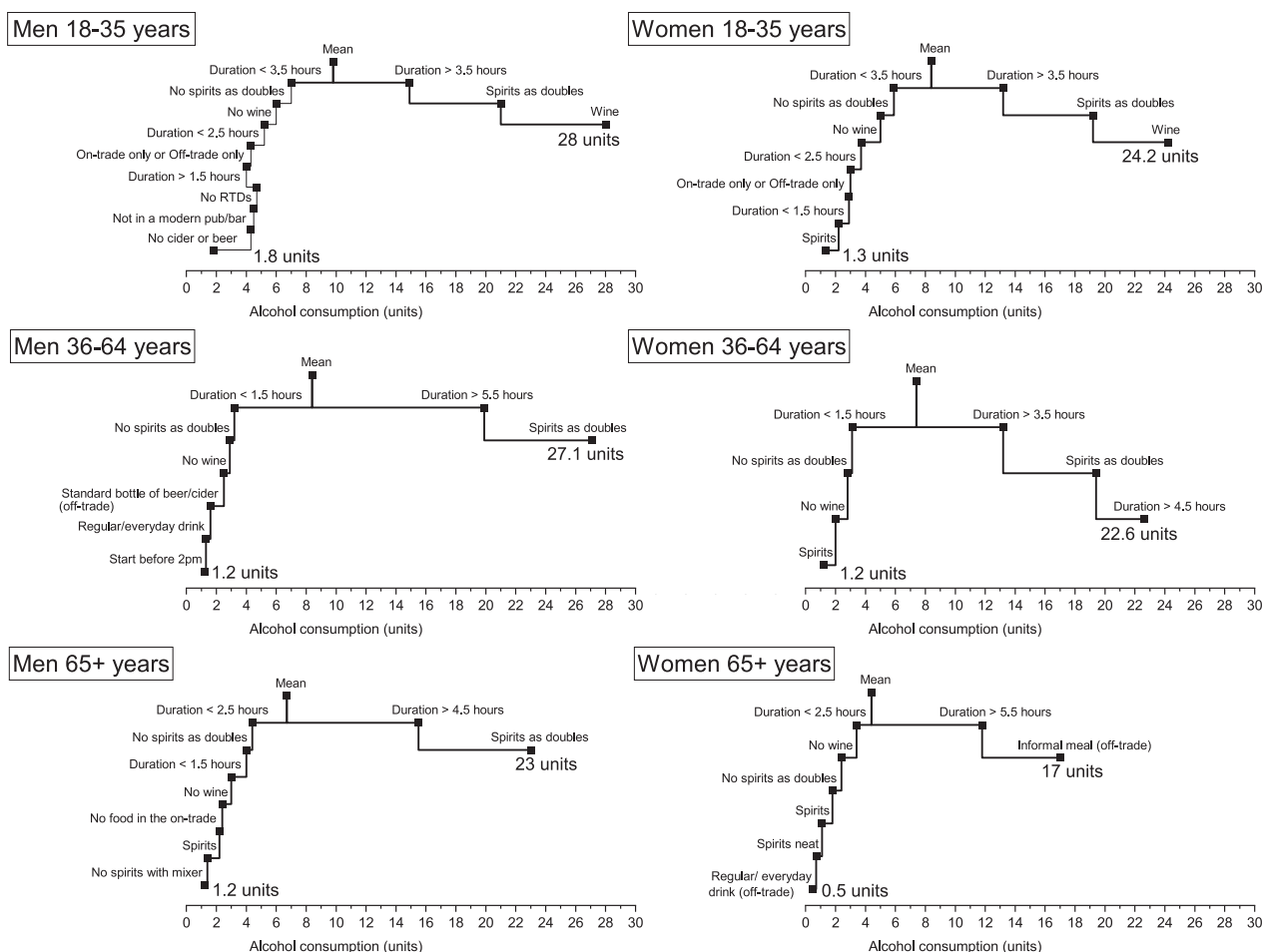


Fig. 2. Pathways through decision trees to the heaviest and lightest occasions (leaves) for 6 age-sex groups. The pathways shown lead to the types of drinking occasions identified by decision tree models with the lowest and highest mean alcohol consumption (in units). As has happened for men aged 18-35, 1 or more of the steps in the process may move the mean consumption in a counterintuitive direction as long as this branch ends up with the lowest mean consumption.

Interestingly, spirits are drunk in both the heaviest and lightest occasion types in different ways (i.e., doubles vs. singles), suggesting that serving sizes may represent important material components of drinking practices, rather than simply incremental differences in consumption levels. The patterns by age-sex group in mean alcohol consumption in the heaviest drinking occasions are as expected—men and younger people consume more units in their heaviest occasions. Conversely, there is little variation in mean units consumed across the lightest drinking occasions, suggesting that all age-sex groups have very light drinking occasions.

Decision Tree Modeling of Occasion Duration

The duration of drinking occasions accounts for a large proportion of the explained variance in units consumed (Figure 1, Table S2). Since some characteristics may influence, or be associated with consumption through longer occasions, we also used decision tree modeling to predict the duration of occasions using all of the other characteristics as predictors.

The trade type of drinking occasions accounts for the highest proportion of variance in occasion duration across all age-sex groups (Figure 3). Drinking in both the on- and off-trade (preloading or postloading) predicts longer occasions than drinking in the on- or off-trade only. Other important predictors are the start time and drinking with friends. There is also an interaction effect between start time and trade type: When drinking occasions start earlier, mixed trade type drinking is more strongly associated with longer duration than it is in occasions that start later (Table S3). Overall, drinking with friends is also an important predictor of longer drinking occasions.

There are patterns in the results across age-sex groups. For example, drinking in a mixed sex group and drinking spirits are more important predictors of female occasion duration and general use of a computer in the off-trade is more important for male occasion duration.

Nested Models Predicting Occasion Alcohol Consumption in Units

We used a series of nested linear regression models to predict the natural log of units consumed per occasion. Firstly, individual-level factors (age in years, usual drinking frequency, and social grade) accounted for between 1 and 9% of the final R², depending on the age-sex subgroup (Table 1). Sequentially adding occasion duration, all other occasion characteristics selected by decision tree models, and the combinations of variables within the terminal groups (leaves) of decision tree models, accounted for 24 to 60%, 28 to 54%, and 3 to 16% of variance, respectively. These findings suggest that each set of predictors accounted for additional variance over and above previous models.

Individual-level factors and occasion duration accounted for more of the variance among 36 to 64 year olds than the other age groups, while other occasion characteristics improved prediction less. Adding occasion characteristics and leaves as predictors had a particularly large effect on the R² for women aged over 65.

DISCUSSION

This study is the first to estimate units of alcohol consumed in adults' drinking occasions using a wide range of occasion characteristics. We found that the occasion

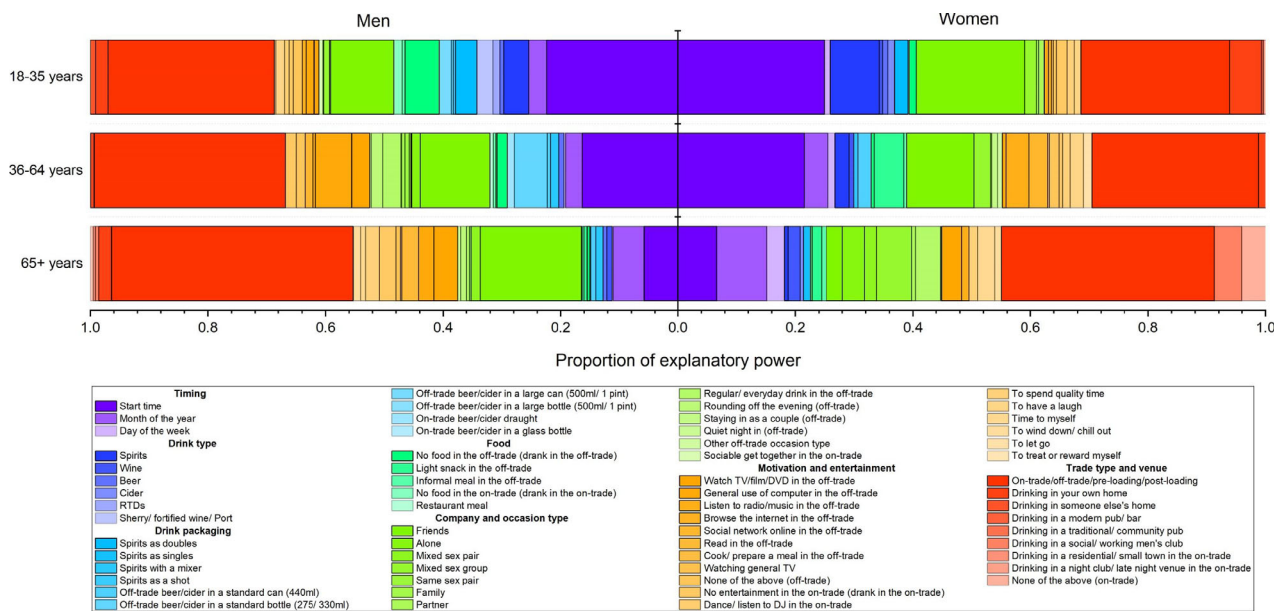


Fig. 3. The proportion of explained variance attributable to each characteristic in models of occasion duration for 6 age-sex groups.

Table 1. Nested linear regression models testing improvements in the prediction of alcohol consumption in units

	Male			Female		
	18-35	36-64	65+	18-35	36-64	65+
Model predictors	R^2 (proportion of total R^2)					
Individual-level factors ^a	0.00 (1)	0.06 (9)	0.03 (5)	0.01 (1)	0.03 (5)	0.04 (6)
+ Occasion duration	+0.24 (44)	+0.38 (60)	+0.31 (51)	+0.25 (45)	+0.31 (53)	+0.17 (24)
+ Other occasion characteristics ^b	+0.27 (48)+0.18 (28)+0.22 (36)					
	+0.27 (49)+0.21 (37)+0.38 (54)					
+ Leaves ^c	+0.04 (8)	+0.02 (3)	+0.05 (8)	+0.03 (5)	+0.03 (6)	+0.12 (16)
Total R^2	0.56 (100)	0.64 (100)	0.61 (100)	0.55 (100)	0.58 (100)	0.71 (100)

^aAge in years, usual drinking frequency, National Readership Survey social grade.

^bThe occasion characteristics selected by decision tree models out of the full set listed in Table S1.

^cThe terminal groups of occasions produced by decision tree models, representing combinations of characteristics. Models used clustered standard error to account for individuals reporting multiple occasions.

duration, beverage type, and serving size are strongly predictive of units consumed. Occasion characteristics improve the prediction of alcohol consumption both individually and in combination relative to models including only demographic characteristics. Combinations of characteristics are therefore useful for understanding levels of alcohol consumption within drinking occasions.

The occasion characteristics measured in the Alcovision survey were not informed by a specific theoretical perspective and our review of previous literature suggests this is common with event-level alcohol research. However, the characteristics measured appear to be suitable for interpretation through a theories of practice lens. In our previous work, we have drawn on Shove *et al.*'s description of the main elements of social practice—materials, meanings and competences—and extended these to include temporal elements (Ally *et al.*, 2016; Meier *et al.*, 2017; Stevely *et al.*, 2019). In this study, we find that temporal factors are particularly important—duration is the strongest predictor of units of alcohol consumed, and start time is strongly related to occasion duration. The day of the week was a less important predictor than might be expected given the cultural association of binge drinking with Friday and Saturday nights in Britain. Our findings suggest that weekend drinking is not heavier once occasion duration is accounted for. However, weekend occasions will involve heavier drinking *if* they have characteristics that are associated with longer occasions, such as drinking in both the on- and off-trade, with friends, and starting earlier in the day. Material elements are also important predictors of occasion consumption and duration—particularly drink type, drink packaging, and venue type. The measures of meaning included in the Alcovision survey were not strong predictors of consumption or duration. This may have been due to the limitations of the market research-oriented measures as we have some findings that suggest the importance of meaning elements. For example, spirits were drunk in both the heaviest and lightest occasions in different ways (i.e., as doubles vs. singles). These differences are evocative of different meanings—perhaps the light occasions involve enjoying a relaxing tittle of whiskey for an hour or

so while the heavy ones involve downing shots which could be linked to “determined drunkenness” (Haydock, 2016; Measham and Brain, 2005). We did not have measures of competencies, such as round-buying or downing drinks.

Exploring the relative importance of different factors in predicting units of alcohol consumed per occasion across demographic groups may also speak to the social organization of practices. Our nested linear models found that occasion duration accounted for the most variance in units consumed among 36 to 64 year olds, while other occasion characteristics were less predictive. A possible explanation is that their daily lives and drinking occasions are more established and routinized so there is less variation in wider occasion characteristics.

Our findings offer some important insights that build on the existing literature. A recent mapping review by Stevely and colleagues (2019) found that the most commonly studied characteristics in event-level alcohol research are the day of the week, affect/mood, and venue type (e.g., pub or restaurant). Just 8.6% of the included papers studied duration of drinking occasions. Based on this analysis, the occasion characteristics commonly studied may not be the most important predictors of alcohol consumption and greater attention should be given to other material and temporal elements. The effects of occasion characteristics also vary across age-sex groups (moderation effects)—however, Stevely *et al.* found that few studies on drinking contexts and acute alcohol-related harm tested for mediation or moderation effects, partly because the literature has a heavy focus on young adult populations (Stevely *et al.*, 2020a).

We used detailed data on the characteristics of drinking occasions collected by the Alcovision survey to estimate units of alcohol consumed. Although it offers novel analytical possibilities, there are important limitations of the Alcovision dataset (Ally *et al.*, 2016). The variables are designed for market research purposes and are often not well-aligned with measures designed for scientific purposes. For example, the drinking motivation measures used are not based on a standard validated survey tool such as the Drinking Motives Questionnaire. There were also no measures of drinking

companions' behavior, drinkers' expectancies, or drinkers' intentions, which previous studies have linked to consumption in drinking occasions (Fillo et al., 2017; Larsen et al., 2009; Monk and Heim, 2013; Stevens et al., 2017). Furthermore, we have not analyzed factors that are associated with having a drinking occasion in the first place. For example, people may be much more likely to drink at the weekend, but weekend drinking occasions may not involve heavier consumption.

Our findings suggest future research and prevention efforts may benefit from using theories of practice to systematically consider elements of drinking occasions. Prevention campaigns building on these findings could promote shorter occasions (or shorter forms of existing practices—such as knowing “when to call it a night”), drunk people could be more stringently excluded from entering on-trade venues to prevent very long occasions across multiple venues, and on-trade venue licensing could restrict the availability of spirits as doubles. Future research could contribute to developing, testing, and evaluating interventions in these areas. It would be particularly valuable to follow up this exploratory work by testing for causal mechanisms that link occasion characteristics and alcohol consumption including combinations, mediation via occasion duration, and moderation by age-sex group.

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CONFLICT OF INTEREST

None to declare.

DATA AVAILABILITY STATEMENT

The Alcovision survey is a commercial product and therefore cannot be made publically accessible.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of the article.

Table S1. Characteristics of drinking occasions.

Table S2. The proportion of explained variance attributable to each characteristic in models of alcohol consumption per occasion for six age-sex groups.

Table S3. The proportion of explained variance attributable to each characteristic in models of occasion duration for six age-sex groups.